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PSYCHOLOGICAL REVIEW

THE OBSERVABLE UNCONSCIOUS AND THE INFERABLE CONSCIOUS IN CURRENT SOVIET PSYCHOPHYSIOLOGY:

INTEROCEPTIVE CONDITIONING, SEMANTIC CONDITIONING, AND THE ORIENTING REFLEX [1]

GREGORY RAZRAN
Queens College, New York

Of the approximately 5,000 reports of experiments on classical conditioning and closely related phenomena that have come out of Russian laboratories since the beginning of the century, approximately 1,500 of which have appeared since 1950, roughly 300—almost all of the since-1950 group—stand out with a particular salience. They stand out, first, because, with only very few exceptions, they are not being duplicated outside the Soviet Union and indeed are hardly known outside it. But more importantly, they stand out because of their own intrinsic worth, in offering highly significant methods and data toward the solution of one of the most vexing problems of contemporary research and thought: the problem of unconscious-conscious interactions and influences in all their applied and systematic ramifications. Somewhat summarily, I would say that these 300 recent Russian experiments contribute greatly toward making the Unconscious observable instead of inferable and the Conscious inferable whether it is or is not observable.

The experiments that I have in mind fall into three separate groups: interoceptive conditioning, semantic conditioning, and studies in the orienting reflex—each group a true supplement to the two others in unraveling and fixing the common problem in its own area. Studies of interoceptive conditioning were begun in the Soviet Union in 1928 but had not gained much empirical momentum until the late '40s; [2] studies of semantic conditioning and of the orienting reflex in its present form are almost wholly a product of Soviet research and thought since 1950.

INTEROCEPTIVE CONDITIONING

Definition and Classification

Interoceptive conditioning may best be defined as classical conditioning in which either the conditioned stimulus (CS) or the unconditioned stimulus

[1] Research done under Grant M-2196 of the National Institute of Mental Health, National Institutes of Health, Public Health Service, United States Department of Health, Education, and Welfare.

[2] Bykov's book *The Cerebral Cortex and the Internal Organs*, translated by W. H. Gantt into English in 1957 (Chemical Publishing Co., New York), first appeared in Russian in 1943 and was never revised; the book thus contains reports of only the early experiments, about 10% of the present total.

(US) or both are delivered directly to the mucosa of some specific viscus. When both stimuli are interoceptive, the conditioning might be called intero-interoceptive. When only the conditioned stimulus is interoceptive but the unconditioned one is exteroceptive, the appropriate name might be interoexteroceptive conditioning, while the designation of exterointeroceptive conditioning might be reserved for situations in which only the unconditioned stimulus is interoceptive. Three varieties thus result, of which the second has been most studied, and is to a large extent the most instructive with respect to both theory and practice.

Moreover, the first two varieties, those of interointeroceptive and intero-exteroceptive conditioning, differ very importantly from the third variety of exterointeroceptive conditioning in that only the first two are true cases of interoceptive signalization. That is to say, only they represent a kind of conditioning in which the viscera, the so-called *milieu interieur,* become the signalizers, or initiators and conveyors, of the acquired conditioned information. The third variety, that of extero-interoceptive conditioning, is different. For in it, though the signaled event is interoceptive, the signalizing is exteroceptive: the viscera or the *milieu interieur* become only the direct receivers of the conditioned information, the signalization or transmission remaining embedded in the external stimuli, the *milieu exterieur.* And to complete the roster, one should add that conventional classical conditioning is wholly exteroceptive or exteroexteroceptive, and that it is so even when it involves stimulation of the mucosa of the oral and nasal cavities.[3]

A more detailed classification of interoceptive conditioning (for that matter, also of exteroceptive conditioning) must take further account of not only the type of stimulus but also the type of reaction conditioned, whether it be visceral, skeletal, or, in the case of human subjects, also sensory-verbal; and it should consider the special cases of exteroceptive verbal stimuli in exterointero- and interoexteroceptive conditioning. A total of 15 varieties of interoceptive conditioning is thus possible, and almost all have been demonstrated experimentally in Russian laboratories. Sample illustrative experiments will be presented in a later section.

General Methodology

With animal subjects, the methods of direct delivery of interoceptive stimulations have involved, as might be suspected, the formation of fistulas in the experimental viscus *in situ* and, when needed, also the surgical exteriorization of the viscus. Space forbids discussion of the Russians' special surgical methods and techniques in the area, of which numerous reports have appeared in recent years. Speranskaya's (1953) *Operative Methods and the Conduct of Chronic Physiological Experiments in Dogs,* the Methods sections in the *Fiziologischesky Zhurnal SSSR im. I. M. Sechenova,* and the *Byulleten Eksperimental'noy Biologii i Meditsiny* (available in English since 1956) are recommended. However, the nature and the manner of delivering the interoceptive stimuli need of course be considered. The most typical stimuli are distentions of the lumen of the viscus through inserted fine-walled

[3] When the conditioned or the unconditioned stimulus is a drug that produces only visceral changes, the conditioning should still be classed as exteroceptive because of the exteroception involved in the administration of the drug. However, when this administration factor is ruled out through repeated injections of a physiological solution, the conditioning is interoceptive.

rubber balloons inflated with air or water. The resulting pressures are almost always controlled and recorded on manometers, and the distentions are calibrated, and often further varied with respect to rhythm of delivery, rate of onset, and sometimes also extent of area stimulated (through the use of balloons of different sizes).

Balloons filled with water at different temperatures are frequently further utilized as thermal stimuli, although, when the lumen of the viscus is small, direct luminal irrigation through inflow-outflow tubes seems to be clearly preferred. Irrigation is also the common means of administering chemical stimuli, a large variety of which are being used. Other forms of stimulation are: scratching rhythmically the mucosa with a Pavlov-type stimulator, jets of air or water as tactile stimuli, and electrical stimulations. A standard procedure of interoceptive conditioning has been the differentiation of its conditioned stimuli from related stimuli: that is, continually reinforcing the conditioned stimuli while presenting the related stimuli without reinforcement until the latter cease to produce any conditioning (or produce it to only an insignificant degree).

Figure 1, taken from a report of an experiment in Ayrapetyants' laboratory (Moiseyeva, 1952, p. 95), offers a representative diagram of current Russian practice in conditioned "education" of dogs. As compared with his predecessor of a generation ago, the dog in the figure is equipped not with just one fistula for salivation but with five fistulas: one gastric; one rectal; two ileocecal, one on the ileal and one on the cecal side of the ileocecal valve; and a salivary fistula mentioned in the text but not shown in the figure. (The figure omits not only the salivary fistula but also the entire arrangement of the exteroceptive food conditioning; its intention is presumably to illustrate only the additions to the traditional Pavlov diagrams of dog conditioning.) Moreover, as seen in the figure, provision is made also for recording the dog's respiration and paw movements in response to electric shock and appropriate conditioned stimuli; indeed it is not uncommon for present-day Russian experimenters to register, during conditioning, in addition, the animals' electroencephalographic, electrocardiographic, plethysmographic, psychogalvanic (PGR), oculomotor, and even electroretinographic and pupillographic changes.

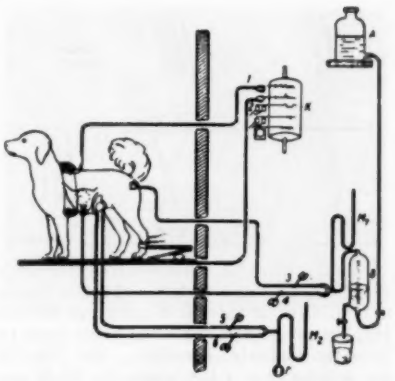

FIG. 1. Conditioning of dogs in Ayrapetyants' laboratory. (Salivary fistula and general arrangement for exteroceptive food conditioning not shown. A—water reservoir; B—graduated vessel; M_1—manometer to measure intragastric pressure; M_2—manometer to measure pressure in ileocecal region; Г—bulb to inflate the ileocecum; K—kymograph; 1—tube connecting respiratory cuff with Marey tambour; 2—tube connecting apparatus registering paw movement with Marey tambour; 3—tube for inflating rectum; 4—tube for inflating the balloon in the dog's stomach; 5, 6—tubes connecting manometer M_3 with the balloons in the ileocecal region, one balloon on the ileal side of the ileocecal valve and one on the cecal side.)

The ileocecal fistula in the figure is of special significance in this particular

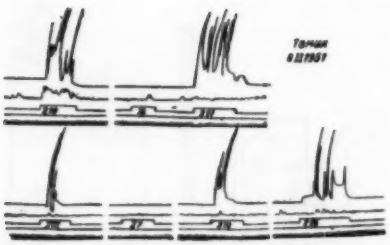

FIG. 2. Ileocecal differential conditioning. (Dog showing paw-withdrawal when cecum next to ileocecal valve is distended at 30-mm. Hg, but no withdrawal when ileum next to valve is similarly distended. No. 210–216 are positive cecal trials, while No. 26–27 are negative ileal trials. Lines from above: paw-withdrawal, respiration, conditioned stimuli, unconditioned stimuli, time in seconds.)

experiment. It has been used by Moiseyeva to train her four dogs to differentiate between ileal and cecal distentions at the same 30-mm. Hg pressure: that is, the animals came to elicit salivation or paw-withdrawal only when one region was distended and not when the other was similarly stimulated. Figure 2 is a kymographic record of such a complete differentiation in dog Tomik. Cecal distentions, positive conditioned Stimuli 210–216, produced paw movement of wide amplitude, whereas ileal distentions, negative Stimuli 26 and 27, failed completely.

With human subjects, on the other hand, two types of techniques in two types of subjects have been used: (*a*) stimulations through fistulas in patients with pre-existing fistulas; and (*b*) swallowing rubber balloons, to which silver electrodes positioned by means of fluoroscopes are often attached, in healthy adult subjects. Figure 3 illustrates the first type of technique. A patient with a urinary bladder fistula volunteered for an experiment in which various unconditioned and conditioned sensory, visceral, and skeletal reactions resulting from, and based upon, distentions of his bladder were thorouoghly investigated by means of an inserted balloon (Ayrapetyants, Lobanova, & Cherkasova, 1952, p. 7). Figure 4 demonstrates the swallowing technique in which, as may be seen, an even wider array of reactions is measured (Makarov, 1959, p. 131). Figure 5 includes two photoplethysmographic records: one of vasoconstriction of the arms when 100 cc. of water at 6°C. was poured into a balloon swallowed by a subject, and one of vasodilatation when the temperature of the water was 43°C. (Pshonik, 1952, pp. 245–246). The significance of using human subjects as checks on, and supplements to, animal experiments needs of course no emphasis.

Sample Experiments with Animals

Ia. Endometrial fistulas were formed in surgically exteriorized horns of three bitches. Glass funnels were fitted into the tops of the openings of the horns to keep out any possible secondary exteroceptive stimulation. When now 10

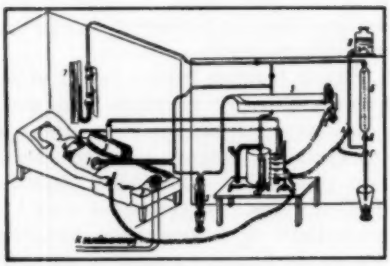

FIG. 3. Apparatus for interoceptive conditioning of human subjects with urinary bladder fistulas. (1—urinary bladder fistula; 2—PGR electrodes; 3—plethysmograph; 4—respiratory cuff; 5—registration of urination; 6—subject's report of sensations; 7—manometer watched by subject; В—graduated cylinder; В—water vessel regulating pressure; А, Г, Д—valves. Russian words at lower left mean "leading to galvanometer.")

seconds prior to feeding the animals, their uterine interior was scratched rhythmically twice a second, or was irrigated by water at 8–12°C., clear-cut conditioned food reflexes with copious salivation and appropriate motor action came to be established. The conditioned reflexes (CRs) first appeared after six to nine trials and became fully stabilized, yielding 40–80 scale divisions of saliva in 20 seconds, after 25–100 trials. Moreover, after CR stabilization, the CSs of the CRs were well differentiated by the usual method of contrasts: the 2-per-second distentions from 1-per-second ones, and the irrigation with water at 8–12°C. from irrigations with water at 44–48°C. When in one experimental session, the horn of one of the animals was anaesthetized with a 1% solution of tetracaine, the CR almost disappeared for the session, and when a fistula was formed in the animal's second horn and the CS of the first horn was applied to it, considerable CR transfer resulted (Fel'berbaum, 1952).

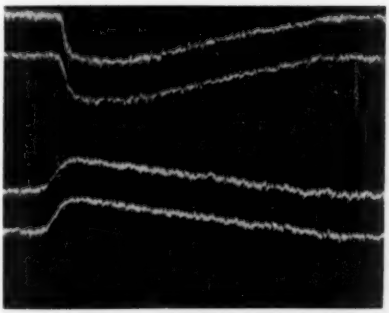

FIG. 5. Changes in volume of arm blood vessels of a human subject when 100 cc. of water at 6°C. or at 43°C. are introduced into his stomach through a rubber tube.

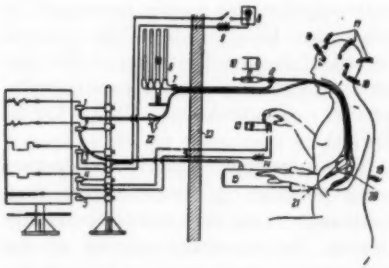

FIG. 4. Swallowing technique for the study of conditioned and unconditioned interoception and their effects on EEG, volume of blood vessels, blinking, and visual sensitivity in human subjects. (1—record of gastric movements; 2—record of arm plethysmogram; 3—marker of light stimulus; 4—subject's report of interoceptive and/or visual sensations; 5—time; 6—burettes to introduce solutions into stomach through opening of Stopcocks 7 and 12; 8—electric bulb; 9 and 14—accumulators; 10—disc of Makarov optic chronaximeter, measuring visual sensitivity; 11—syringe to draw out liquid contents of stomach; 13—key to signal gastric or visual sensations; 15—plethysmograph; 16—electrical registration of blinks; 17—EEG electrodes; 18—indifferent EEG electrode; 19—indifferent electrode for electrical stimulation of the stomach; 20—gastric balloon; 21—electrodes and leads of balloon; 22—terminal of balloon lead; 23—partition between experimenter and subject. Swallowing technique has also been used to study interaction between interoception and respiration, cardiac action, and galvanic skin reflex.)

Ib. The fistulated uterine interior of bitch Zita was stimulated by a jet of air and, after 10 seconds of such stimulation, an electric shock was administered to the animal's right-hind paw. Conditioned paw-withdrawal to the mere air stimulation first appeared after 5 trials and became stabilized after 10–11 trials. Figure 6 shows a kymographic record of such conditioning at Trials 40–42. As may be seen from the figure, the CR is quite unmistakable and surely very much marked; indeed, the extent of the conditioned paw-withdrawal appears to have been no less and even greater than the unconditioned one (Lotis, 1949).

The two experiments thus demonstrate rather clearly the formation and differentiation of interoexteroceptive uterine conditioning of both the vis-

FIG. 6. Conditioned withdrawal of a female dog's paw upon stimulation of her uterus. (Lines from above: paw-withdrawal; conditioned stimulus, stimulation of uterus with a jet of air; ordinal number of application of conditioned stimulus; unconditioned stimulus, electric shock; time in seconds.)

ceral and the skeletal variety—their data corresponding fully to what one finds in reports of conventional extero-exteroceptive conditioning à la Pavlov and à la Bekhterev with the use of bells, metronomes, buzzers, lights, odors, epidermal taction, thermostimulation, and other exteroceptive CSs.

II. Thiry-Vella intestinal loops were formed in five dogs who, in addition, were tracheotomized to permit, by means of inserted cannulae attached to gas chambers, direct (bypassing the oral cavity) regulation of the amount and gaseous composition of inhaled air. After the animals had become fully adapted to the respiratory apparatus, showing no observable special reactions to its use in breathing normal air, the composition of the air was changed to include 10% of carbon dioxide, which, as might be expected, produced a wide variety of hypercapnic respiratory changes and defensive reactions (including the contraction of the spleen). Now, when the changes and the reactions were repeatedly preceded by the rhythmic distentions of the animals' intestinal loops (90–100 distentions in one minute at 60–80 mm. Hg pressure), hypercapnic conditioning was quickly observed.

The first hypercapnic CRs appeared after 3–6 trials and they became quite stable after only 5–16 trials; moreover, the animals readily and successfully differentiated the conditioned distentions from distentions at a rate of 15 per minute at 55–60 mm. Hg pressure, when the latter were presented without reinforcement for 6–15 trials. The same animals conditioned even more readily their hypercapnic reactions to a Tone 1a and differentiated them from stimulation with Tone re (CS generalization was ruled out), and both the exteroceptive and the interoceptive conditionings were in all cases highly resistant to extinction. When the two types of CSs were presented in very close succession, the interoceptive CSs mostly decreased the CRs to the subsequent exteroceptive CSs, whereas the exteroceptive CSs mostly increased the subsequent CRs. Figure 7 is a partial record of the manifestation of the two types of CRs in the same experimental session (Pogrebkova, 1950, 1952a, 1952b).

This experiment illustrates two new main varieties of interoceptive conditioning: interointeroceptive—conditioning the mechanoreceptors of the intestine to stimulations of the arterio-chemoreceptors of the lungs; extero-interoceptive—conditioning auditory

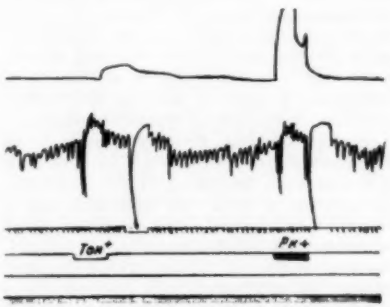

FIG. 7. Hypercapnic extero- and interoceptive conditioning in dogs. (Lines from above: general movement of animal; respiration; lung ventilation; conditioned stimuli, first, auditory, second, distention of intestine; unconditioned stimuli; time in 2-second units.)

stimuli to such stimulations. Moreover, each main variety involved the conditioning of both skeletal and visceral reactions, thus raising the total number of new varieties to four, which, combined with the two varieties of Experiments Ia and Ib, completes the experimental demonstration of all varieties of interoceptive conditioning possible with animal subjects. Again, we might note that the hypercapnic conditioning, both the interoceptive and the exteroceptive, was very fast and stable, a result that should probably be attributed to the unusual arousal nature of the large excess of inhaled carbon dioxide, threatening the very existence of the organism's vital functions and mobilizing fully its adjustive vigilance. And we might add that decremental effects of juxtaposing two kinds of CSs of the same CR, as observed in the results of the juxtaposition of the exteroceptive and the interoceptive CSs in this experiment, are unusual when the two kinds of CSs are both exteroceptive, let us say, visual and auditory. Or, in other words, there is indication here that conditioning to interoceptive stimuli conflicts with conditioning to exteroceptive stimuli in a way that conditioning to exteroceptive stimuli of different modalities does not: that is, interoceptive conditioning is in an important way a class of conditioning by itself, a matter for which more evidence and discussion are adduced in later sections. Finally, we might point to another striking result of the cited study, the finding that while, after prolonged experimentation, the dogs became adapted to breathing the unusual air, the CSs continued to elicit, in a number of cases, widespread aversive organismic reactions.

IIIa. The duodenum of dog Laska was inflated three to four times in 5 seconds with 30–40 cc. of air. On the fifth second a single 4-volt electric shock was administered to the animal's left-hind paw with electrodes attached to the *articulatio talo cruralis*. Conditioned paw-withdrawal in response to the inflation first appeared on Trial 5. After reinforced Trial 129, the duodenal inflation, now no longer accompanied by shock, was joined by the sound of a buzzer, the sound lasting for 15 seconds and preceding the inflation by 10 seconds. After 18 such trials, the sound of the buzzer came to elicit clear-cut withdrawal of the animal's left paw with some movements of the right paw and respiratory changes, even though the sound was never associated with the administration of the electric shock. Figure 8 unmistakably

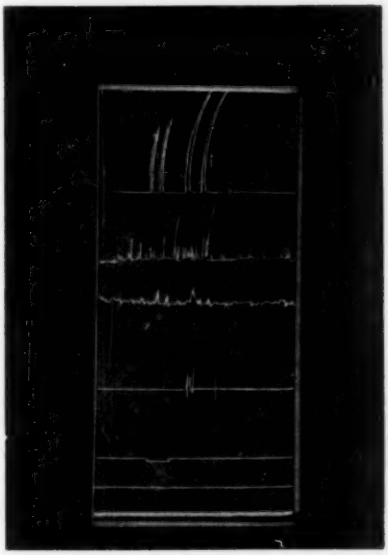

FIG. 8. Second-order interoceptive paw-withdrawal conditioning in dogs. (CS_1 interoceptive, CS_2 exteroceptive. Lines from above: movement of conditioned left-hind paw; movement of nonconditioned right-hind paw; respiratory changes; first-order conditioned stimulus, distention of intestine with 30–40 cc. of air; second-order conditioned stimulus, sound of buzzer; unconditioned stimuli; time in seconds.)

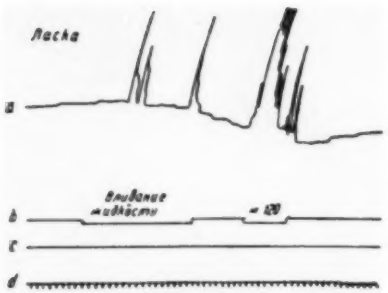

FIG. 9. Second-order interoceptive paw-withdrawal conditioning in dogs. (CS_1 exteroceptive, CS_2 interoceptive. Lines from above: paw-withdrawal; conditioned stimuli, first, irrigation of intestine with water for 15–30 seconds, second, metronome of 120 beats per minute; unconditioned stimuli; time in seconds.)

demonstrates this conditioning based upon a previously conditioned interoceptive CS (Vasilevskaya, 1948, 1950).

IIIa$_1$. Stable conditioned paw-withdrawals, based on the administration of electric shock, to the sound of a metronome of 120 beats per minute were formed in two dogs, who had intestinal loop fistulas, one dog by the method of Thiry and the other by the method of Thiry-Vella. When now prior to the sounding of the metronome, the intestinal loops of the animals were repeatedly irrigated with water at room temperature for 15–30 seconds, clear-cut paw-withdrawals in response to the mere irrigations were noted in one dog after 21 trials and in the other after 46 trials. Figure 9 is a record of the new and of the original conditioned reflex in one dog. The data indicate that the new CR was by no means as stable as the original one; yet, as seen in the figure, it was quite substantial and unmistakable in magnitude. This experiment differs from the one preceding in that in it the second-order, the CS-based, and not the first-order, the US-based, CR was interoceptive (Pauperova, 1952).

IIIb. Distentions of the small intestines of six dogs at 40–100-mm. Hg pressure were accompanied for 7–20 trials by exteroceptive stimulations (sound of a whistle, the flash of a 200-watt lamp, or the odors of ammonia), after which either the distentions or the exteroceptive stimulations were repeatedly accompanied by the administration of an electric shock to one of the animal's paws. When a stable conditioned paw-withdrawal was formed to the shock accompanied stimuli, it was found that the shock unaccompanied stimuli also elicited paw-withdrawal in most cases. Some of these US-unaccompanied CRs were highly resistant to extinction, requiring 3 to 5 days of nonreinforced applications to disappear completely, and no essential differences were noted between cases in which the distentions were the original CSs and the exteroceptive stimuli were the unaccompanied stimuli and cases in which the experimental situation was reversed. Moreover, in three other dogs, clear-cut conditioned paw-movements were formed to "natural" gastric contractions when the contractions were accompanied by the sound of a whistle or the flash of a 200-watt light and the sound or flash were accompanied by a shock to the

FIG. 10. Conditioned paw movements of a dog to "natural" gastric contractions when the contractions were accompanied by a flash of a 200-watt lamp and the flash was in turn accompanied by an electric shock to the animal's hind paw when its stomach was at rest. (Lines from above: pneumogram; gastric contractions; paw movements; flashing of light, not administered.)

animal's hind paw only when the stomach was at rest. Figure 10 shows the data of such conditioning in one of the three dogs (Goncharova, 1955, p. 165).

The three experiments demonstrate two special types of conditioning: (*a*) second-order conditioning, when conditioning is effected through associating a stimulus with a previously conditioned stimulus (CS_1 is associated with a US and then a CR is formed to CS_2 through associating it with CS_1); and (*b*) associated conditioning (Russian term) or sensory preconditioning (American term), when conditioning is effected by associating a stimulus with a to-be-conditioned stimulus, that is, prior to the latter's CR training (CS_x is associated with CS_y and then a CR is formed to CS_x or CS_y by virtue of the preconditioning association). Both types of conditioning are special in the sense that they are not very readily demonstrable and it is thus important to note that they occur also when either one of the two CSs is interoceptive in nature. The preconditioning or associated conditioning of the paw movements to the gastric contractions is furthermore a special case in that the contractions were, as indicated, natural and not laboratory produced, and are of course motor and not sensory reactions.

A few years ago (Razran, 1955a), the author argued in this journal that

FIG. 11. Conditioned contraction of the rumen and the reticulum in sheep, with electrical stimulation of the mucosa of the rumen as the US and the sound of a bell as the CS. (Lines from above: contraction of the reticulum, contraction of the lower portion of the rumen, contraction of the upper portion, contioned stimuli, unconditioned stimuli, time in 30-second units.)

FIG. 12. Conditioned contraction of the rumen and the reticulum in sheep, with distention of the rectum as the US and the sound of an electric bell as the CS. (Lines from above: contraction of the reticulum, contraction of the rumen, conditioned stimuli, unconditioned stimuli, time in 30-second units.)

second-order conditioning is an infrequent phenomenon and is likely to involve cognitive intervention whenever it occurs. The manifestation of this type of conditioning at the interoceptive level as well as a reanalysis of the evidence for its existence in conventional exteroceptive conditioning, plus an analysis of new evidence at the exteroceptive level, forces the author to retract hereby his former view. The infrequency of the phenomenon appears to be due almost wholly to experimenters' failures to observe certain stimuli sequences that are conducive to its laboratory production.

IV. Fistulas were formed in the rumen, reticulum, and rectum of six karakul sheep. It was found that electrical stimulation of either the animals' epidermis or the mucosae of their rumen, reticulum, or rectum, as well as the distention of their rectum, produced considerable reductions in the periodic contractions of the rumen and reticulum and increases in the rumen-reticulum ratio of contraction. Conditioning was now attempted by ringing a bell a few seconds prior to each of the five aforementioned unconditioned stimulations, and it was successful in all cases. The number of trials needed for the first appearance and for the stabilization of the CR were, respectively: 7–13, 16–24 when the epidermis was stimulated electrically; 6–11, 13–18 when the stimulation was applied

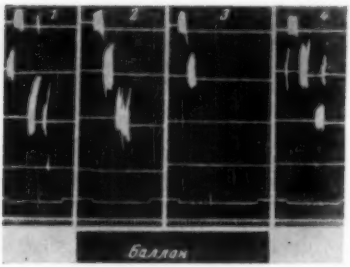

FIG. 13. Dogs' conditioned choices of dishes of 15 cc. of milk of varying salt contents. (CS—gastric inflations with 300–500 cc. of water in inserted rubber balloon. US—administration of 300–500 cc. of 3–5% of a salt solution through a gastric fistula. Strip below main figure shows insertion and removal of balloon, CS. Lines from above: milk with 1%, 2.5%, 3.5%, and 5% of salt contents; response to water dish; and time record.)

to the mucosa of the rumen or reticulum; 17–21 when it was administered to the rectum; and 20–24, 39–44 when the stimulation was the distention of the rectum. Figure 11 is a kymographic record of a CR with electrical stimulation of the rumen as the US, and Figure 12 is one when the US was the distention of the animals' rectum (Dedashev, 1959).

This experiment is of special interest in that it involves special organs as loci of stimulation, the reduction and cessation rather than the production of reactions as CRs, and the use of animals other than dogs as subjects. Moreover, as will be noted, the experiment contains a certain amount of evidence to indicate that the speed of formation of exterointeroceptive conditioning, unlike that of the interoexteroceptive variety (evidence not brought out in presented experiments), may well not be slower than the speed of formation of extero-exteroceptive conditioning.

V. In a pilot experiment with dogs (number not given), the experimenter observed that the salt appetite of the animals was markedly decreased when 300–500 cc. of a 3–5% of an aqueous salt solution had been introduced into their gastric fistulas. The salt appetite was determined through permitting the dogs to choose any of several dishes of 15 cc. of milk containing varying amounts of dissolved salt. When now the administrations of the aqueous salt solutions were preceded by distentions of the animals' stomachs by means of inserted rubber balloons into which 300–500 cc. of water was poured, it was found that the mere distentions became conditioned reducers of the salt appetite. Figure 13 presents the data of such conditioning in one dog. As may be seen from the figure, the animal came to refuse milk of 5% salt contents after the balloon had been in his stomach for awhile but took it when the balloon was removed (Kassil', 1959).

The experiment is significant in demonstrating in preliminary fashion interoceptive conditioning of a comparatively complex choice reaction. A recent American experiment by Cook, Davidson, Davis, and Kelleher (1960) demonstrates 100% avoidance conditioning to jejunal pressure in rats. The experiment is, as far as the reviewer is

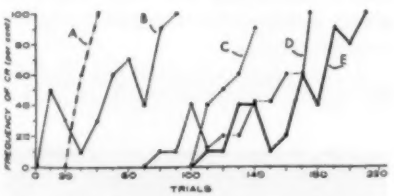

FIG. 14. Representative avoidance acquisition curves for each type of conditioned stimulus. (Each curve represents the results obtained with a single animal. Conditioned stimuli: A—tone, B—acetylcholine, C—*l*-norepinephrine, D—jejunal pressure, E—*l*-epinephrine. Different dogs were used in each experiment. Each point represents the percentage of conditioned leg flexions occurring in blocks of 10 successive trials.) (Reproduced from *Science* by permission)

aware, the first one in true interoceptive conditioning performed in this country, and it would seem worthwhile to present its main data. Figure 14, taken from the report of Cook et al., is self-explanatory.

VI. The urinary bladders of two dogs, a male and a female, were removed, their ureters externalized, and the ureteral orifices sutured to their skin. Normal functioning of the kidney continued. But, as might be expected, there was a loss of the familiar micturition reflex—leg lifting, etc. in the male, and squatting, etc. in the female. Yet, when these dogs saw other dogs urinating, the micturition pattern (getting near a wall, smelling, and leg lifting or squatting) was almost fully restored (Ayrapetyants, 1952, p. 25).

The observation is interesting because it discloses "natural" exterointeroceptive conditioning: that is, conditioning an interoceptively aroused reflex to exteroceptive stimuli—the sights and smells of other dogs—that naturally accompany it.

Sample Experiments with Human Subjects

Ia. Three patients with urinary bladder fistulas volunteered for a series of experiments in which distentions of their bladders, through calibrated inflows of air or of physiological solutions, were thoroughly investigated. Careful recordings were made of: (*a*) the rate and amount of the inflow; (*b*) bladder compression resulting from the contraction of *M. detrusor urinae* and transmitted by means of inserted rubber balloons attached to mercury or spring manometers; (*c*) the rate and amount of urine secretion; and also (*d*) the accompanying respiratory, vascular, and psychogalvanic changes—while, in addition, the subjects (*e*) signaled the time and intensity of their urination "urges." The manometers,

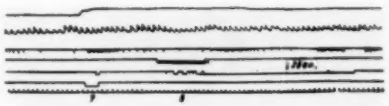

FIG. 15. Interoceptive urinary conditioning in man. (Lines from above: intrabladder pressure; pneumogram; urination; conditioned stimulus, manometer sham reading of 40-mm. Hg; subject's report of urinary urge; unconditioned stimulus, introduction of air into bladder; time in 3-second units.)

equipped with conspicuous dials, were always watched by the patients, so that their scale readings—and column heights or angle displacements—could be used as conditioned stimuli when the manometers were detached (without the patients' knowledge) and the readings were varied independently by the experimenter.

Conditioning to the sham readings was effected readily in all cases. The patients began reporting intense urination urges, accompanied by all or most of the aforementioned objective reaction changes, when the manometer readings were high (normal or above normal of what they were while effecting the urge in the training session) even though the inflows were minimal or totally omitted. On the other hand, low or zero readings failed to produce the urge and its accompaniments, even if the inflow was considerably above that which normally produced it; much increased, sometimes double, inflows were now needed to be fully effective (in some cases, the failure was evident only with respect to the urge and the urination, but in others, it meant also absence of any measurable muscular tension—Ayrapetyants et al., 1952). Figures 15 and 16 are records of this conditioning.

Corresponding results were obtained later in patients with intestinal fistulas and with instructions or words as CSs (Ayrapetyants, 1956), while in a pre-

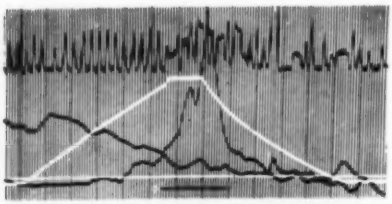

FIG. 16. Interoceptive urinary conditioning in man. (Black lines from above: pneumogram, PGR, intrabladder pressure, subject's report of urinary urge. Upper white line is the conditioned stimulus—the experimenter's moving upward the readings of the manometer. The lower white line is for the unconditioned stimulus—filling the bladder with air; not used in the test, bladder empty.)

liminary pilot study it was shown that a patient with an intestinal fistula, who discriminated accurately an inflow of cold water at 6–8°C. from that of warm water at 40°C., began to report sensations of cold in response to the flash of a red lamp that had been combined eight times with the cold inflow (Ayrapetyants, 1949, p. 37).

Ib. Experimenter noted that when his subjects were told to inhale, they manifested clear-cut plethysmographic arm vasoconstriction in addition to changes in their pneumograms, as may be seen in the left portion of Figure 17. The particular vasoconstriction is apparently a viscerovisceral vasomotor reflex evoked by the respiration. Now, the experimenter told his subjects not to inhale when the word "inhale" was given. But, as may be seen in the right portion of the figure, the vasoconstriction persisted despite the entirely regular pneumogram—it was, presumably, "naturally" conditioned to the word inhale and was not deconditioned—or inhibited—by the instructions "not to inhale when inhale is uttered" (Okhnyanskaya, 1953).

Experiment Ia discloses six varieties of exterointeroceptive conditioning: sensory (report of sensations), motor (respiratory changes), and visceral (vascular and electrodermal reactions), in response to both sensory and verbal CSs. A highly significant special finding of the experiment, and one that no doubt points to the great power of its methodological design, may be noted in Figure 16. As the CSs increased in magnitude—as the experimenter moved the manometer dials upward—changes occurred first in the PGR, then in the intrabladder pressure, and then in respiration and urination urges; when the CSs decreased, the sequence was reversed, except that respiratory fluctuations continued for nearly as long as those of the PGR.

Experiment Ib, which was already indicated as an example of "natural" exterointeroceptive conditioning, seems by all tokens to shed light on two intricate CR mechanisms: (*a*) the chaining of classical conditioning and the CR efficacy of a three-link exteroceptive-interoceptive-interoceptive CR chain when the middle link is omitted, and (*b*) the deconditioning or reversing power of instructions upon previously conditioned verbal stimuli. The experiment is obviously one that could be readily duplicated—and expanded—in any American laboratory.

II. Fine walled, inflatable rubber bal-

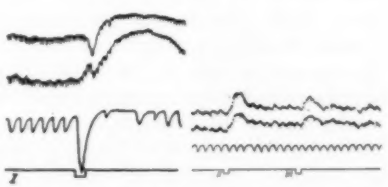

FIG. 17. Conditioned interoceptive vascular changes in human subjects. (Plethysmograms and pneumograms to the sound of the word "inhale" when (*a*) the subjects were told to inhale—left portion of figure—and when (*b*) they were told *not* to inhale when they heard the word "inhale"—right portion of figure.)

loons folded into tubes and equipped with three-pronged silver electrodes positioned by fluoroscopes were swallowed by four healthy human subjects, including the experimenter, P. O. Makarov of Leningrad University. The technique permitted recording a vast array of visceral, skeletal, and verbal-sensory reactions when the stomach was distended, or stimulated electrically. As the stimuli increased in intensity, an extensive period of no-sensation or presensation, in which only visceral and skeletal changes occurred, was noted. With further increases in intensity, came a period of dull and heavy poorly localized sensations of "something"; and with still further increases, a period of fairly clear and fairly localized acute pain. When in the sensation period the active electrodes were positioned 8 cm. apart and each point was stimulated separately, stimulations at intervals of less than 15 milliseconds were reported as single sensations localized between the two stimulated points. When the intervals were 55–105 milliseconds, the reports were of two successive sensations in the same locus; while intervals greater than 105 milliseconds resulted in reports of two successive sensations in two discriminable loci, the correctness of the spatial discrimination being further a regular function of the lengthening of the intervals (Makarov, 1950a, p. 395). Figure 18 is an illustration of the results.

The value of an exact experimental analysis of direct visceral stimulation and sensation in man can hardly be overemphasized, both because of our present almost total ignorance of the field and because of the unique way in which it permits the separation of conscious from unconscious reactivity, a slow-motion way of unfolding a changing panorama that, surely, studies of epidermal and other exteroceptive stim-

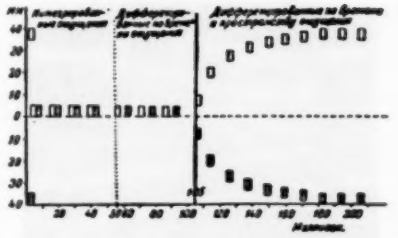

FIG. 18. Two-point threshold in electrical stimulations of the gastric mucosa of human subjects. (From left to right, Russian words mean: "integrated [fused] sensation," "temporal discrimination," "spatial discrimination." Units on abscissa are interstimulation intervals in milliseconds; units on ordinate are distances between stimulation points in millimeters.)

ulations with their low and quick conscious thresholds can by no means emulate.

III. Inflatable gastric tubes were swallowed by three healthy human subjects, 26–32 years of age, to study the interaction of thermal interoceptive and exteroceptive stimulations by means of a modified Novitsky arm photoplethysmograph.[4] After the subjects had become fully adapted to the apparatus and consistently produced only symmetrical records, four types of interoceptive-exteroceptive interactions were investigated: cooling the inside of the stomach by 100 cc. of cold water at 6°C., 10–15 seconds prior to warming the epigastric region with a special 43°C. "thermode"; warming the inside of the stomach with 100 cc. of water at 43°C., 10–15 seconds prior to cooling the outside with a 6°C. thermode; cooling the outside of the stomach with the 6°C. stimulus prior to warming it in-

[4] The Novitsky photoplethysmograph appears to be essentially the same as that described recently by Shmavonian (1959). The Russians have been using this technique extensively for about 10 years in recording digital and forehead changes in blood volumes.

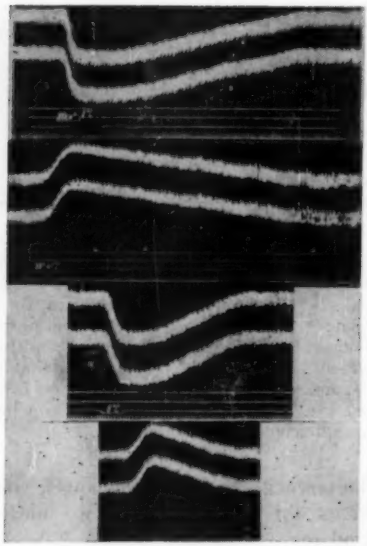

FIG. 19. Arm plethysmograms of human subjects when 100 cc. of water at 6°C. is poured into gastric balloon which the subjects swallowed (upper figure); 100 cc. of water at 43°C. is poured into the balloon (upper middle figure); a 6°C. stimulus is applied to the subjects' epigastric region (lower middle figure); a 43°C. stimulus is applied to their epigastric region (lower figure).

side with the 43°C. water; and warming the outside of the stomach with the 43°C. stimulus before cooling it inside with the 6°C. water.

At first, as might be expected, vasoconstrictions followed by vasodilatations were noted in the first and third series of the experiment and vasodilatations followed by vasoconstrictions in the second and fourth. However, as the experiment continued and interaction set in, the modifications in the first two series of the experiment in which the interoceptive stimuli and reactions preceded the exteroceptive ones contrasted strikingly with those in the last two series in which the sequence was reversed. In both the first and the second series, the preceding reactions—vasoconstriction in the first series and vasodilatation in the second—suppressed the opposing succeeding reactions and indeed became themselves somewhat strengthened, presumably at the expense of the succeeding reactions; whereas in the third and fourth series, the preceding reactions, on the contrary, became clearly weakened and the succeeding reactions strengthened as the unconditioned stimuli of the former were converted into conditioned stimuli for the latter. Or, in other words, in either case the exteroceptive stimuli lost their original functions

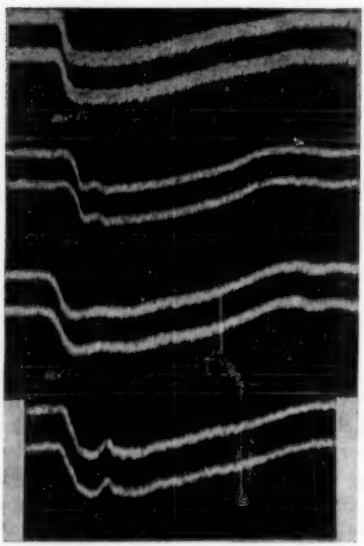

FIG. 20. Arm plethysmograms of human subjects when cooling their gastric mucosa at 6°C. precedes by a few seconds warming their epigastric region at 43°C. (Upper figure—the plethysmograms in response to the cooling prior to its combination with the warming; upper middle figure—the cooling and the warming combined; lower middle figure—cooling after a number of cooling-warming combinations; lower figure—experimenter saying "I am cooling the stomach on the inside" a few seconds before warming the epigastric region at 43°C.)

and the interoceptive reactions became dominant.

Figure 19 is a record of the vasomotor reactions prior to the interoceptive-exteroceptive and the exteroceptive-interoceptive interactions; it shows that the reactions to the two types of stimuli were about equal in magnitude and pattern. Figure 20 demonstrates the dominance of interoceptive reactions when interoceptive cooling and resulting vasoconstriction preceded exteroceptive warming and resulting vasodilatation (first series of experiment). Figure 21 illustrates interoceptive dominance when interoceptive warming and resulting vasodilatation succeeded exteroceptive cooling and resulting vasoconstriction (third series). The results of sequences of interoceptive warming-exteroceptive cooling (second series) and exteroceptive warming-interoceptive cooling (fourth series) were quite similar. And it might further be noted that: (*a*) as seen in Figure 20, the interoceptive reactions dominated the exteroceptive ones even when the former were produced by verbal CSs as "I am cooling the stomach on the inside" and the latter by their USs, warming at 43°C.; and that (*b*) the modifications in the exteroceptive-interoceptive sequences were of a classical CR type whereas those in the interoceptive-exteroceptive sequences were of an operant CR type. The last statement points to two far-reaching theoretical implications: that the possibility that operant conditioning is somehow related to interoceptively (and proprioceptively) produced (and interoceptively and proprioceptively conditioned) behavior; that the relative

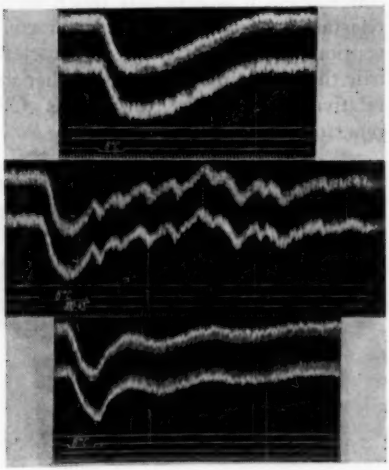

FIG. 21. Arm plethysmogram of human subjects when warming their gastric mucosa at 43°C. succeeds by a few seconds cooling their epigastric region at 6°C. (Upper figure—the plethysmogram in response to the cooling prior to its combination with the warming; middle figure—the cooling and the warming combined, note fluctuation; lower figure—cooling after a number of cooling-warming combinations.)

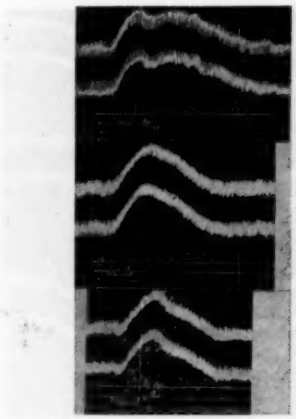

FIG. 22. Conditioned vasodilatation of the blood vessels of the arms of human subjects to the flash of a blue light after the light had been combined a number of times with warming the subjects' epigastric region with a 43°C. stimulus on odd trials of a CR stereotype. (Upper figure—record when the flash of the light was, after a few seconds, reinforced by the warming; middle figure—the flash of light applied alone; lower figure—experimenter saying "I am flashing on a blue light.")

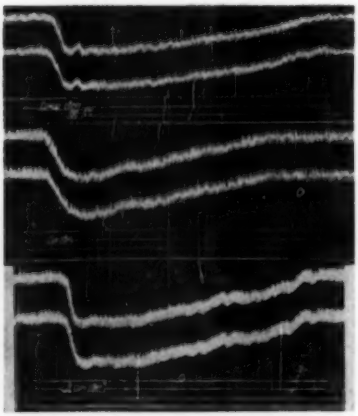

FIG. 23. Conditioned vasoconstriction of the blood vessels of the arms of human subjects (subjects of Figure 22) to the flash of a blue light after the light had been combined a number of times with cooling the subjects' gastric mucosa with water at 6°C. on even trials of the same CR stereotype. (Upper figure—record when the flash was, after a few seconds, reinforced by the cooling; middle figure—flash applied alone; lower figure—experimenter saying "I am flashing on a blue light.")

dominance of a reaction determines in some way the type of conditioning—classical or operant—that the reaction undergoes. The matter will be considered fully in a later theoretical section.

In another part of the experiment, a "vascular neurosis" was formed in three subjects through the disruption of a CR stereotype (pattern) in which the flash of a blue light preceded the warming of the epigastric region at 43°C. on odd trials and the cooling of the gastric mucosa at 6°C. on even trials. Figures 22 and 23 show the clear-cut normal functioning of the CR stereotype. Vasodilatation was produced when the blue light was flashed or the words "I am flashing on a blue light" were pronounced on odd trials (Figure 22), whereas on even trials the same stimuli yielded vasoconstriction (Figure 23). Moreover, similar results were obtained with a CR stereotype in which the flash of a red light preceded the cooling of the epigastric region at 6°C. on odd trials and the warming of the gastric mucosa at 43°C. on even trials (Pshonik, 1952, pp. 240–295). Yet note in Figure 24 what happens when the trial sequence is disregarded and the blue or red light is flashed: wholly irregular and conflicting vasomotion, which, the experimenter adds, was accompanied by vomiting, sensory distortions, and complaints of headache.

The striking and instructive results of the experiment hardly need comment, except to add that while, as was already indicated, interoceptive conditioning—that is, intero-exteroceptive conditioning—is slower in formation than is exteroceptive conditioning, once conditioned, it is generally much more resistant to extinction than is the conventional classical variety, a characteristic that no doubt augments further its relative role in the organism's CR repertory.

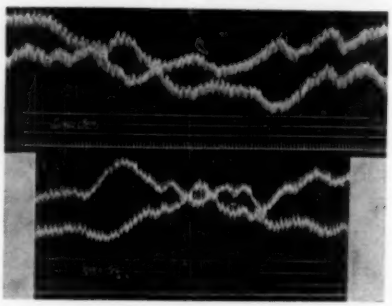

FIG. 24. Marked vascular fluctuation ("vascular neurosis") in response to the flash of the blue light when the cooling and the warming are no longer regularly alternated and the CR-stereotype is thus disrupted (upper figure). Lower figure shows similar results of an experiment in which the flash of a red light was the conditioned stimulus, the epigastric region was cooled, and the gastric mucosa was warmed.

IV. A human patient, whose rectum was removed through surgery and a colostomy installed, continually reported strong defecatory urges and sensations in the area of the nonexistent rectum whenever the attendant removed the feces from his system (Ayrapetyants, 1952, p. 26). Another patient, whose ureters were externalized and sutured to the large intestine, learned to distinguish between urinary and defecatory urges, the distinction being connected in some way, according to the patient's report, with differences between internal sensations following drinking and eating (Bykov, 1943, p. 255).

These two clinical examples by all tokens show "natural" interoceptive visceromotor and sensory conditioning to exteroceptive and interoceptive stimuli (sight of attendant, reported internal stimulation; cf. the observations on the micturition reflexes of the dog and the bitch with removed urinary bladders in the preceding section).

Summary and Special Significance: The Observable Unconscious

The selected 14 experiments on interoceptive conditioning, both animal and human, the experiment on unconditioned interoception in healthy human subjects, and the three clinical observations, in the main, epitomize well, it is believed, the present state of knowledge of the field as reflected in approximately 100 reports of recent Russian experiments. In recapitulation, this knowledge might be compressed into six principal propositions:

1. Unlike the continuum of exteroceptive stimulation which is the body-material of all our conscious experience, the continuum of interoceptive stimulation leads largely to unconscious reactions.

2. Interoceptive conditioning, whether involving conditioned or unconditioned interoceptive stimuli, is readily obtainable and is by its very nature largely unconscious in character.

3. While interoceptive conditioning is by its nature more limited than is exteroceptive conditioning with respect to total kinds and variety of stimulations, the interoceptive kinds of stimulations are, on the other hand, by their very nature much more recurrent, periodic, and organism-bound, making interoceptive conditioning an almost built-in function that is constantly generated and regenerated in the very process of living and acting.

4. Interoceptive conditioning is somewhat slower in formation than is exteroceptive, but, once conditioned, it is more fixed and irreversible (less readily extinguished).

5. When equal but opposing interoceptively produced and exteroceptively produced reactions are juxtaposed, the interoceptive reactions dominate the exteroceptive ones, with the final result that preceding exteroceptive stimuli become conditioned stimuli for succeeding interoceptive reactions whereas preceding interoceptive reactions become strengthened by exteroceptive reactions succeeding them.

6. The juxtaposition of conditioned interoceptive and exteroceptive stimuli of the same conditioned reaction, unlike similar juxtapositions of exteroceptive stimuli of different modalities, produces a certain amount of conflict and decrementation of conditioning.

Of the six propositions, the last three, the more specific ones, might still be in need of further empirical evidence to settle fully their status and parameters. However, there should be absolutely no doubt about the finality of the first three general propositions—the ubiquity, largely unconscious character, and ready all-round conditionability of interoceptive stimulations. And this alone, the author contends,

suffices to add a wholly novel dimension to our thoughts about conscious and unconscious reactions, and the Conscious and the Unconscious as such, in experimental-theoretical psychology, Freudian theory, and applied psychosomatics.

A good number of psychologists hold, for instance, to the view that classical conditioning is either wholly a function of cognitive-perceptual expectancies and anticipations, inferred or observed; merely a mechanical subsidiary of integrated goal directed means-end adjustive behavior; or altogether a pseudophenomenon without its own ontological or heuristic status. The clear-cut experiments in interoceptive conditioning in all its attributive forms cited here—and they are, as stated, only a sample—can scarcely be thus interpreted. Indeed, without denying or minimizing the role of perceptual and adjustive factors in higher and more complex levels of learning, one is almost forced to think of a reverse position—notably, one that accords the many empirical facts of simple unconscious interoceptive learning the status of a prime model of all learning and lets the complex varieties seek subsidiary principles when and if the model is inadequate. The aforementioned psychologists, it might well be argued, have not yet, despite many efforts, really given up their traditional tendencies of preferring observations *von oben herab* [from above down] to *von unten herauf* [from below up], and of ignoring, or insufficiently advancing, physiological and surgical means that extend the horizon and expand the dimensions of directly observable behavior. Instead, the argument might run further, these psychologists continue to be rooted in data and concepts that are mainly derived from either analyses of their own private experience (phenomenology) or observations of gross and global behavior without the benefit of the empirics of underlying finer mechanisms. (The last statement pertains not to a neural analysis, but to a finer behavioral one: the almost ever-present parameters of interoception and interoceptive conditioning are behavioral!)

The relevance of interoceptive conditioning to Freudian theory may be even more evident. For, obviously, no matter how far removed Freudian dynamics is from psychophysiological dynamics at present, its eventual material validation—and it is assumed that such validation is at least a future desideratum of the system—will rest largely upon expanded psychophysiological knowledge of the contents of visceral action and of the mechanisms of shifts or associations of such action and contents. Studies of interoception, particularly of human interoception, and of animal and human interoceptive conditioning are clearly concerned with just this. And while the sexual contents of visceral action, at least in human subjects, is not readily experimentable and our general knowledge of contents of visceral action is still quite meager, the experimental information on shiftings of visceral actions is already, as may have been noted, too substantial and too instructive to be passed over by any follower of Freud, whatever his attitude toward physiological validation may be. Consider not only the ready two-way conditionability or shiftability (or displacement or transference) of basic unconscious visceral action, but also the relative irreversibility of the shifts, the evidence of conflicts resulting from the juxtaposition of interoceptive and exteroceptive stimulations, and the dominance of interoceptive reactions over exteroceptive ones of the same measurable magnitudes.

Put somewhat differently, we might say that the many and varied attempts

made in the past to synthesize the teachings of Freud with known facts of conditioning (and learning) have suffered from at least three obvious shortcomings: (*a*) They were based on evidence that, with only very few exceptions, came from experiments on conditioning that is conscious in content (that is, of which human subjects are conscious and animals—dogs and rats—are assumed to be conscious) and thus is outside the main operational material of Freud's doctrines. (*b*) The conditioning units of the evidence, at least as far as classical conditioning is concerned, were in the main organismically inconsequential; even the classical unit of salivation is obviously not within the center of the organism's needs and action, not to mention blinking, finger- or paw-withdrawal, knee jerk, galvanic skin reflex, and others. (*c*) The attempts lacked evidence on unconditioned and conditioned organism generated stimulations and the resultant organism generated–environment generated antinomy—an antinomy that, it must be remembered, is only related to, but by no means identical with, the more known exteroceptive somatic-visceral and conscious-unconscious antinomies, and that by all tokens should be of vital significance to the very core of Freudian psychodynamics. The sample experiments cited here purport to obviate the aforementioned shortcomings, although, of course, compared with the magnitude of the Freudian problem, the experiments may offer only pilot formulations and their contributions may so far be largely methodological.

Space forbids special discussion of the relation of applied psychosomatics to interoceptive conditioning. The fact that interoceptive conditioning involves the modifications of functions of vital organs and that it multiplies threefold the possibilities of such modifications should suffice. For, in accordance with the experimental evidence of interoceptive conditioning, not only, let us say, may feelings of anxiety, or its unconscious visceromotor accompaniments, become conditioned stimuli for the production of, let us say, constipation, but also unconscious rectal distentions, or sensations of constipation, may equally be conditioned to bring about conscious and unconscious anxiety or bring about abnormal bile secretion or gout, asthma, dyspnea, hypertension, angina pectoris, or any other functional disturbance. It should, however, be pointed out, with respect to both Freudian psychodynamics and psychosomatics, that, in general, interoceptive conditioning may perhaps best be regarded as primarily a correlate of Freud's so-called primary processes. Freudian symbolism and secondary processes pertain, no doubt, predominantly to the realm of conscious and unconscious verbal and semantic conditioning, to which the next section of the article is devoted.

SEMANTIC CONDITIONING

Problem and History

Semantic conditioning may be defined as the conditioning of a reflex to a word or sentence irrespective of the particular constituent letters or sounds of the word or the particular constituent words of the sentence: that is, conditioning to meaning (more specifically, to sense or meaning since some semanticists accord the status of meaning only to sentences or propositions). Its experimental analysis is an outgrowth of the object-word (or sensory stimulus-word) and word-object (or word-sensory stimulus) CR transfer noted in the Russian laboratories of Krasnogorsky and Ivanov-Smolensky in the late '20s and early '30s, when, for instance, a conditioned reflex to the sound of a metronome carried over to

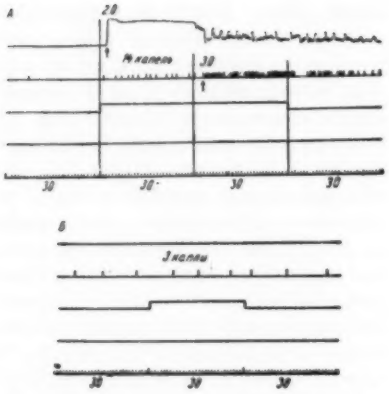

FIG. 25. Positive salivary conditioning to the word *khorosho* [good, well] and negative salivary conditioning to the word *plokho* [poorly, badly, bad] in a 13-year-old boy. (Upper figure data are for *khorosho*, lower for *plokho*. Lines from above in each figure are: motor action of jaw, drops of saliva, conditioned stimulus, unconditioned stimulus, time in seconds; arrow in second line of upper figure refers to beginning of eating. Russian words in the second line of the upper figure mean "14 drops"; in lower figure, "3 drops.")

the sound of the word metronome or vice versa. However, studies of phonetographically unrelated word transfer of conditioning, and indeed of any word-word CR transfer, originated in this country, as did also the term semantic conditioning itself. The author used the term first in *Science* (Razran, 1939b) when he had found that three college students, conditioned to secrete a mean of 249 mg. of saliva per minute to the sight of the words style, urn, freeze, and surf, had transferred their conditioning more to words fashion, vase, chill, and wave than to stile, earn, frieze, and serf.

The author's results were almost wholly duplicated by Riess (1940) who used the galvanic skin reflex and who, in addition, uncovered a positive correlation between semantic conditioning and age (Riess, 1946). In later experiments, the author reported: a crude semantic gradient to traditional association categories (subordinate, contrasts, part-whole, whole-part, coordinate, and supraordinate—Razran, 1949a, 1949b, 1949d, 1949e); more salivary CR transfer from the sentence "Poverty is degrading" to "Wealth is uplifting" than to "Poverty is not degrading" (Razran, 1949c); and a sentential distribution of conditioning in accordance with parts of speech (Razran, 1952). Several other American experimenters engaged in the problem, notably Lacey and his collaborators (Lacey & Smith, 1954; Lacey, Smith, & Green, 1955) with highly instructive results and implications. But, in general, there has been little concerted effort in the area in this country, while the Russians have, in recent years (1952 on), advanced it with special speed and planning.

Sample Russian Experiments

1. Yuri K., 13 years old, was conditioned to secrete a considerable amount of saliva when the word *khorosho* [well, good] was pronounced and to differentiate from it the sound of the word *plokho* [poorly, badly, bad]. Figure 25 shows that when the two words were put in sentences *Khorosho uchenik otvechayet* and *Plokho vorobey poyot,* Yuri secreted, respectively, 14 and 3 drops of saliva in 30 seconds. (The literal translation of the two sentences is: "Well the student answers" and "Poorly the sparrow sings"—Russian word-order is wholly flexible and each of the two adverbs could have been in any position without appearing at all unusual.) Table 1 includes data on the subject's 30-second conditioned salivation to the words *khorosho* and *plokho* and to 16 sentences. Nine of the 16 sentences must have evoked in the subject attitudes of approval (*khorosho*); six, attitudes of disap-

TABLE 1

SALIVATION OF 13-YEAR-OLD BOY TO VARIOUS WORDS AND PHRASES AFTER HE HAD BEEN CONDITIONED POSITIVELY TO THE WORD *Khorosho* [Well, Good] AND NEGATIVELY TO THE WORD *Plokho* [Poorly, Badly, Bad]

Trial No.	Time of experimentation		Words or phrases tested	Test No.	Saliv. dps. in 30 sec.
	Date	Exact time			
1	6/26/52	11:20′00″	*khorosho*	47	9
2		11:25′15″	*Uchenik prekrasno zanimayet-sya* [The pupil studies excellently.]	1	14
3		11:29′15″	*Deti igrayut khorosho* [The children are playing well.]	1	19
4		11:31′15″	*plokho*	11	2
5		11:32′45″	*khorosho*	48	15
6		11:37′00″	*Sovet-skaya Armiya pobedila* [The Soviet Army was victorious.]	1	23
7		11:42′00″	*Uchenik nagrubil ychitel'nitse* [The pupil was fresh to the teacher.]	1	0
8		11:45′15″	*khorosho*	49	18
9		11:49′45″	*Pioner pomogayet tovarischu* [The pioneer helps his comrade.]	1	23
10	7/31/52	10:10′00″	*khorosho*	50	18
11		10:14′00″	*plokho*	12	1
12		10:17′00″	*khorosho*	51	16
13		10:21′00″	*Leningrad—zamechatel'ny gorod* [Leningrad is a wonderful city.]	1	15
14		10:24′30″	*Shkol'nik ne sdal ekzamen* [The pupil failed to take the examination.]	1	2
15		10:26′00″	*khorosho*	52	15
16		10:29′30″	*Brat obizhayet sestru* [Brother is insulting sister.]	1	1
17	8/1/52	11:20′00″	*khorosho*	54	12
18		11:25′30″	*Rybaky poymali mnogo ryby* [The fisherman caught many fish.]	1	18
19		11:31′30″	*Sovet-skaya konstitutsiya—samaya demokraticheskaya* [The Soviet Constitution is the most democratic (of all).]	1	17
20		11:36′30″	*Fashisty razrushili mnogo gorodov* [The Fascists destroyed many cities.]	1	2
21	8/1/52	11:40′30″	*Uchenik razbil steklo* [The pupil broke the glass.]	1	2
22		11:41′30″	*Sovet-sky narod lyubit svoyu Rodinu* [The Soviet people love their Motherland.]	1	17
23		11:45′30″	*Moy drug tyazhelo zabolel* [My friend is seriously ill.]	1	2
24		11:47′30″	*Vrazheskaya armiya byla razbita i unichtozhena* [The enemy army was defeated and annihilated.]	1	24
25		11:51′30″	*Uchenik sdal ekzamen na posredstvenno* [The pupil passed the examination with a mediocre grade.]	1	10

proval or condemnation (*plokho*); and one (the last sentence) was most likely of an intermediate or indeterminate attitude category.

As seen from the table, the conditioned salivation during the action of the "approval" sentences ranged from 14 to 24 drops in 30 seconds. During

TABLE 2

SALIVATION OF 13-YEAR-OLD BOY TO DIFFERENT ARITHMETICAL OPERATIONS AFTER HE HAD BEEN CONDITIONED POSITIVELY TO "10" AND NEGATIVELY TO "8"

Trial No.	Time of experimentation		Arithmetical operations tested	Test No.	Saliv. dps. in 30 sec.
	Date	Exact time			
1	8/12/52	11:10'00"	83−73	1	15
2		11:14'00"	5+5	1	16
3		11:18'30"	20−12	1	2
4		11:20'30"	1000÷100	1	18
5		11:24'30"	5×2	1	19
6		11:28'00"	56÷7	1	2
7		11:32'00"	24−14	1	19
8	8/14/52	13:15'00"	19−9	1	7
9		13:19'00"	8+2	1	19
10		13:22'30"	48÷6	1	3
11		13:23'30"	4×2	1	2
12		13:24'00"	80÷8	1	17
13		13:27'30"	112−102	1	11
14		13:29'30"	4+4	1	3
15		13:31'30"	470÷47	1	11
16	8/14/52	13:33'00"	99−91	1	3
17		13:35'00"	80÷8	2	21
18		13:38'00"	88÷11	1	3
19		13:40'30"	35−25	1	25

the action of the "condemnation" sentences, the range was from 0 to 2 drops, and during the action of the "intermediate" sentences the salivation amounted to 10 drops for the 30 seconds. No secretion was evident when the experimental sentence was "The pupil was fresh to the teacher," but 24 drops were produced when the sentence was "The enemy army was defeated and annihilated," and 23 drops when it was "The pioneer helps his comrade."

Later, in a second experiment, the same subject formed a positive salivary CR to the word *desyat'* [ten] from which he differentiated the word *vosem'* [eight], and was then confronted with 19 arithmetical problems, to 11 of which the answer was "ten" and to 8 of which the answer was "eight." The results are presented in Table 2, from which it may be seen that the "answer ten" problems produced from 7 to 25 drops of saliva in 30 seconds, with a median of 17 drops, whereas none of the "answer eight" problems yielded more than 3 drops in testing periods of the same duration. The "answer ten" problems were effective even when "eight" was a part of them (Problems 9, 12, and 17).

Finally, in a third experiment, the boy was conditioned positively to the word *vosemnadtsat'* [eighteen] from which he differentiated the word *chetyrnadtsat'* [fourteen], and then presented with arithmetical problems: $9+9$, $90\div5$, $72\div4$, and $2{,}232\div124$. His results are given in Figure 26. As may be noted in the figure, $9+9$ yielded 18 drops of saliva in 30 seconds with a latency of 2 seconds; $90\div5$ produced 13 drops with a 6-second latency; $72\div4$ evoked 9 drops at an 11-second latency; and $2{,}232\div124$, 2 drops and a latency of 7.8 seconds (Volkova, 1953).

The extremely fine reflection of the subject's thoughts, and no doubt sub-

vocal speech, in the conditioned salivation is indeed very striking.

II. Conditioned vasoconstriction was formed in nine adult human subjects to the words *dom* [house] and *doctor* [doctor] by combining the words with the application of a 10°C. round lead disc to the dorsal side of the subjects' left arms and recording the conditioned vasoconstriction in both arms photoplethysmographically. CR transfers to phonetographically related words *dym* [smoke] and *diktor* [announcer] and to the semantically related and phonetographically unrelated English word house (subjects knew the language) and Russian word *vrach* [physician] were tested at early and late stages of CR training, and after the administration of 1 gm. of chloral hydrate. Figure 27 shows that the phonetographic CR transfer to the word *dym* was evident only in the early stage of training (8 trials); that it disappeared when the CR was well established (after 25 trials); and that, strikingly, the transfer reappeared 30 minutes after the administration of chloral hydrate to the subjects. Figure 28 brings out the finding that the semantic CR transfer from the Russian word *dym* to the English word house disappeared 30 minutes after administration of the same dose of the drug. The results with the words *dictor* and *vrach* are said to have been quite similar (Shvarts, 1954, 1960).

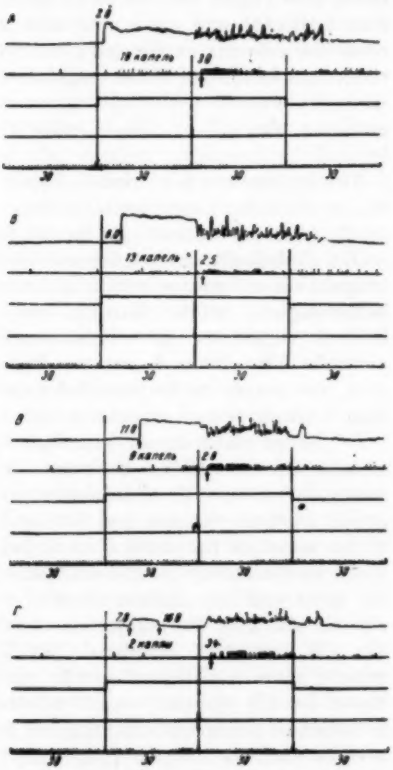

FIG. 26. Semantic salivary transfer in a 13-year-old boy conditioned to the sound of the word *vosemnadtsat'* [eighteen]. (Figures from above down show results when the transfer stimuli were, respectively: 9 +9, 90 ÷ 5, 72 ÷ 4, 2,232 ÷ 124. Lines in each figure from above are: motor action of jaw, drops of saliva, verbal stimulus, unconditioned stimulus, time in seconds; arrows refer to beginning of eating. Russian words in the figures from above down mean: "18 drops," "13 drops," "9 drops," and "2 drops.")

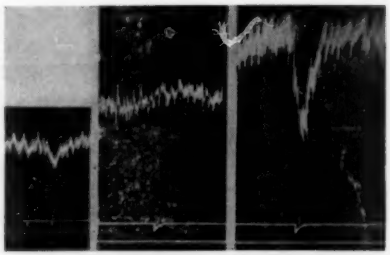

FIG. 27. CR transfer of vasoconstriction from conditioned word *dom* [house] to phonetographically related word *dym* [smoke]. (Left figure—transfer after 8 conditioned trials; middle figure—loss of transfer after 25 conditioned trials; right figure—recovery of transfer 30 minutes after administration of chloral hydrate.)

The experiment thus demonstrates, first, that semantic conditioning is a

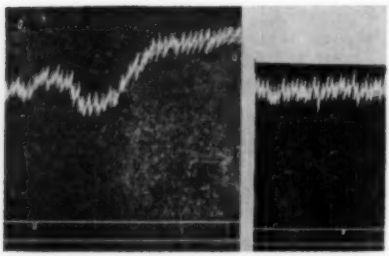

FIG. 28. The effect of the administration of chloral hydrate upon semantic CR transfer of vasoconstriction from conditioned word *dom* to English equivalent house (subjects knew English). (Left figure—transfer before administration of the chloral hydrate; right figure—loss of transfer after the administration of the depressant.)

manifestation of a higher level of our learning potentialities and, second and moreover, that the lower level, the phonetographic manifestation, is not nonexistent in us but is held in abeyance and reasserts itself in periods of lower organismic functioning. As such, the results are seemingly in line with those of Riess (1940, 1946) on the positive correlation between semantic conditioning and age, with Luria and Vinogradova's (1959) comparisons of semantic conditioning in normal and feebleminded children, with some of my own findings, and with what might be expected on general principles.

III. Markosyan (1953) has demonstrated that the reduction in time of blood coagulation produced by the administration of an electric shock could be conditioned in nine rabbits to the sound of a whistle or of a metronome of three beats per second, and that the CR to the metronome could be differentiated so that it was not evoked by beats of one per second. In a later experiment (1958), Markosyan reported that human subjects (he does not state how many) formed coagulation CRs to the sound of a metronome and that these CRs transferred from the sound of the metronome to the sound of the word metronome and to phonetographically related words *metrostroy, metropol', mikrotom,* and *mikroskop.* When now he had conditioned the blood coagulation to the flash of an electric lamp, he found CR transfer to the words *lampochka* [lamp], *fonar'* [lantern], *svet* [light] but not to the word *svist* [whistle], and, again, that after a while the subjects manifested clear-cut reductions in time of blood coagulation when he merely told them "[you're getting a shock]" or "[it is going to hurt]."

The experiment is obviously important in disclosing experimental evidence on the presence of semantic factors in such a phyletically old function as blood coagulation, a function which Western hematologists, unlike Russian ones, tend to regard as not within neural control. The obtained data are, however, too scanty to be accorded more than a tentative and suggestive status.

IV. Seven university students formed vasoconstrictive CRs, recorded by means of a special photoplethysmograph from the fingers and forehead, to the sound of the word *skripka* [violin], by combining the presentation of the word with the administration of an electric shock to the subjects. After the CR was well stabilized (18–27 trials), three varieties of words were tested for CR transfer: words related in different phonetographic degrees to *skripka* such as *skrepka* [paper-clip], *strizhka* [hair cutting, shearing], and *skrytnost'* [reticence, secrecy]; words related in different semantic degrees such as *smichok* [violin bow], *gitara* [guitar], *struna* [string], *mandolina* [mandolin], *arfa* [harp], *baraban* [drum], *orkestr* [orchestra], *sonata,* and several others; and wholly unrelated words such as *stakan* [glass], *lenta* [ribbon], *voda* [water], etc. The main results show transfer to all the

semantically related words, phonetographic transfer to only the word *skrepka,* and, of course, no transfer to the unrelated words. The semantic transfer was of two kinds: one in which the transfer words duplicated the vasomotor changes of the conditioned word, viz., vasoconstriction of both the finger and the forehead blood vessels, and one in which the transfer words elicited vasoconstriction of the vessels of the fingers but vasodilatation of the vessels of the forehead. The phonetographic transfer to *skrepka* was only of the second, vasoconstriction plus vasodilatation, kind—a kind which the Russians identify with the arousal of the orienting reflex. By and large, with respect to the semantically related words, the duplicative kind of transfer was manifest when the transfer words were closely related to the conditioned word, and the orienting kind when the relationship was less close.

Other results of the study might be summed up as follows. (*a*) The amount of the CR transfer—that is, the magnitude of the vasomotor change—was largely a positive function of the degree of semantic relationship of the transfer words to the conditioned word. (*b*) In the course of CR training, the transfer became restricted in scope, duplicative transfer changing into the orienting variety and orienting transfer disappearing altogether. (*c*) The scope of the transfer readily widened when a semantically related transfer word was reinforced with the electric shock. (*d*) However, when the reinforced word was unrelated to the conditioned word such as the word *korova* [cow], a new family of semantic-transfer words such as *telyonok* [calf], *loshad'* [horse], *byk* [bull], and *stado* [herd] came into being. (*e*) When a word had a double meaning, one related to the conditioned word and one unrelated, the word manifested transfer when it was applied after related words and no transfer when it was applied after the unrelated words. (*f*) Subjects' knowledge of the purpose of the experiment and experimenter's instruction modified considerably the course of the conditioning and the transfer but did not wholly nullify or reverse it. (*g*) Postexperimentally, subjects sometimes reported that transfer words had been accompanied by shock stimulations, and there was in general little correlation between postexperimental recall of a word and CR transfer to it during the experiment; indeed, some subjects reported words that had not been used by the experimenter.

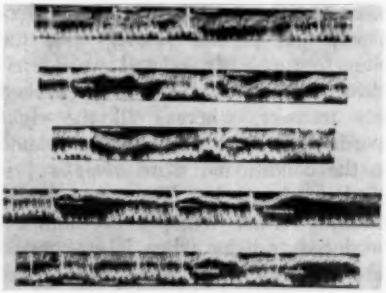

FIG. 29. Verbal transfer of vasomotor CR formed to word *skripka* [violin], with electric shock as the US. (Two subjects—upper four strips, one subject; lowest strip, the other. Lower record—finger plethysmogram; upper record—forehead plethysmogram. Words from upper left: *strizhka* [hair cutting, shearing], *plat'ye* [clothes], *pianino* [piano], *pugovitsa* [button], *truba* [trumpet, chimney], *skripach* [violinist], *smychok* [violin bow], *arfa* [harp], *vilka* [fork], *mandolina* [mandolin], *fleyta* [flute], *violonchel'* [violoncello], *stul* [chair], *kamin* [fireplace], *pechka* [stove], *truba* [trumpet, chimney], *baraban* [drum], *truba* [trumpet, chimney].)

Figure 29 presents data for two subjects (upper four strips for one, lowest strip for the other). As may be seen from the figure, none of the seven unrelated words—*plat'ye* [clothes], *pugovitsa* [button], *kastryula* [saucepan],

vilka [fork], *stul* [chair], *kamin* [fireplace] and *pechka* [stove]—nor the phonetographically related word *strizhka* [hair cutting, shearing] evoked any transfer, whereas all the eight words that were semantically related to the conditioned word *skripka* [violin] produced it. The word *truba*, meaning either trumpet or chimney, produced transfer when it was tested after *baraban* [drum] but was ineffective when tested after *pechka* [stove] preceded by tests for *kamin* [fireplace] and *stul* [chair]. Again, it may be noted in the figure that in the early stages of the CR training the words for piano, violinist, and violin bow elicited duplicative transfer while the words for trumpet and harp evoked the orienting kind (upper three strips of figure); and that in later stages (fourth strip) the magnitude of the transfer for the words meaning mandolin and violoncello was larger than that for the word meaning flute (Vinogradova & Eysler, 1959).

The cited experiment no doubt contains a comprehensive array of significant findings on semantic conditioning. Unfortunately, however, because of a total absence of statistical treatment of data, only the main results of the existence of semantic CR transfer, the near-absence of phonetographic transfer, the existence of the semantic transfer in both a duplicative and an orienting form, and perhaps also the positive effects of context on semantic CR transfer could be considered demonstrated with any degree of significance.

V. Ten normal school children, 11–15 years of age, and 15 feebleminded children of different degrees of feeblemindedness, 13–17 years of age, were told to press a button when they heard the word *koshka* [cat], which resulted in consistent constriction of the blood vessels of the children's fingers and dilatation of the vessels of their forehead, in response to the mere sound of the word. A large number of words related semantically or phonetographically to *koshka*, and some neutral unrelated words, were now presented to each child to test for resulting transfers of the vascular reactions. Clear-cut differences are stated to have been obtained between the normal and the feebleminded children and among the children of different degrees of feeblemindedness. The normal children transferred their vascular reactions only to semantically related words. The children of moderate degrees of feeblemindedness manifested both semantic and phonetographic transfers, while the transfer of the children of extreme feeblemindedness was only phonetographic. (There are no IQs in the USSR.) Again, it is stated that in the moderately feebleminded children repeated reinforced presentations of the instructional word *koshka* increased the amount of semantic transfer; that a presentation of the word *okoshko* [window] in its own semantic context—after the words *derevo* [tree], *dom* [house], *dver* [door], and *stena* [wall]—decreased phonetographic transfer; and that fatigue in general decreased semantic transfer and increased the phonetographic kind.

The experimenters (Luria & Vinogradova, 1959) present data for 6 of their 25 subjects in six figures. Figure 30 is a composite of four of these figures. The upper strip of the figure shows that a normal child, 11–12 years of age, manifested semantic but not phonetographic transfer—to the words *sobaka* [dog] and *zhivotnoye* [animal] but not to the words *okoshko* [window] and *kroshka* [crumb]. The upper middle strip of the figure shows that the transfer of a 16-year-old "mild oligophrenic" or "debile" child was both semantic and phonetographic—to both *sobaka* [dog] and *kroshka* [crumb];

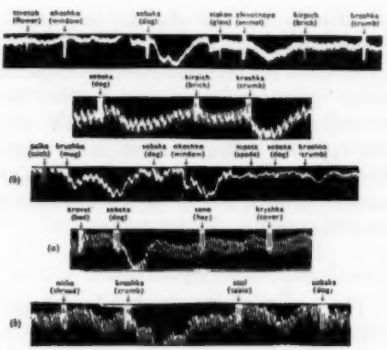

FIG. 30. Verbal transfer of a vascular orienting reaction to word *koshka* [cat] in four school children. (Upper strip—normal 11–12-year-old child; upper middle strip—16-year-old "mild oligophrenic" or "debile"; middle strip—16-year-old "imbecile," greater degree of feeblemindedness; lower middle strip—17-year-old "debile" at beginning of school day; lowest strip—same subject after 6 hours of schoolwork, effects of fatigue.) (Reproduced from the *British Journal of Psychology* by permission)

while the lower middle strip shows that the transfer of a 16-year-old "imbecile" (greater degree of feeblemindedness) was only phonetographic—to *kryshka* [cover] and *kroshka* [crumb] but not to *sobaka* [dog]. The lowest strip of the figure demonstrates that a "17-year-old debile," who transferred his vascular reaction to *sobaka* [dog] but not to *kryshka* [cover] before his school day began, reversed the transfer—to *kryshka* but not to *sobaka*—after 6 hours of schoolwork. (Experimenters' figures not represented in the composite figure pertain to effects of context and of repetition of reinforcement.)

As in the preceding experiment, the data are not reported to have been treated statistically and, as indicated, records of only one subject of each of the three groups varying in intelligence —normal, "debile," and "imbecile"— are presented. Yet, it might be pointed out that the results on the relation of semantic conditioning to intelligence are quite in line with those of Riess (1946) on the relation of this conditioning to age, with some of my own studies, and with common sense; and that the results on the effects of fatigue are quite similar to those of the administration of chloral hydrate in the study by Shvarts (1954) discussed earlier. Moreover, the experiment is of special methodological significance in offering a simple way of studying semantic transfer without recourse to laboratory conditioning. A full report of this experiment and a comprehensive summary of the one preceding appeared in the May 1959 issue of the *British Journal of Psychology*.

VI. Thirty university students, 20–29 years of age, were conditioned to withdraw their fingers when they heard any of three short Russian sentences by combining each of the sentences with the administration of an electric shock to the subjects' fingers. The three sentences were: *Vklyuchayu tok* [I am switching on / the shock], *Rukopis' prochitana* [The manuscript / was read], and *Student vyderzhal ekzamen* [The student / passed / the examination]. (The diagonal bars in the parentheses mark off the equivalents of each Russian word.) After the withdrawal CRs to the sentences were stabilized, CR transfer to the separate words of each sentence was tested. It was found that in the first sentence each of the two words acquired 100% transfer on the first trial; that in the second sentence neither word showed any immediate transfer; while in the third sentence, the word *vyderzhal* [passed] manifested transfer in 87% of the cases, the word *ekzamen* in 50%, and the word *student* in only 10% of the tests. The experimenter attributes the results to differences in total sentential "meaning load" carried by the separate words of the respective sen-

FIG. 31. CR semantic analysis of "I gave him a new ball" and *"Ya dal yemu novy myach."* (Relative CR weights of individual syntactical units.)

tences: that is to say, in the first sentence the total sentential meaning was implied in each of the two words, in the second it was implied in neither, while in the third the sentential meaning was differentially distributed among the three words (Elkin, 1955).

In a previously reported experiment the writer studied the semantic role of parts of speech in salivary conditioning (Razran, 1952). He used three five-word Russian sentences, the meaning of which the subjects learned pre-experimentally, and eight subjects, four of whom were conditioned to the sentences and tested with separate words, and four for whom the sequence was reversed. The sentences were: *Ona khocket kupit' serry koshelyok* [She / wants / to buy / a gray / purse], *Belokuraya devochka nashla zolotoye pero* [The blond / girl / found / a gold / pen], and *Ya dal yemu novy myach* [I / gave / him / a new / ball]. As might be expected, the results of the three sentences did not fully correspond. Yet, they did indicate the preponderant semantic role of verbs and direct objects, the considerable role of infinitive complements, and the rather small role of subjects, indirect objects, and qualifying adjectives. Figure 31 shows such an analysis for one sentence. No doubt many more sentences need to be thus conditioned and tested to settle the finding, the ruling out of differences due to lexical rather than to sentence-membership factors being a particularly laborious task.

Significance and Implications

The number of experiments on semantic conditioning is considerably smaller than that on interoceptive conditioning. Yet in a way these experiments uncover an area of even wider significance, a vast realm of experimentally separable meaning-units continually entering in complex functional relationships with each other and with nonmeaning units, existing both in and out of consciousness, and normally, whether conscious or unconscious, forming controlling rather than controlled systems. Small wonder that the significance of semantic conditioning extends to such varied fields as: the psychology of thinking, ranging from the *unbewusste Bewusstseinslagen* of the Würtzburg school to modern views of cognition as a high level, controlling mechanism of which we may not be aware; Freud's symbolisms, secondary processes, and conscious-unconscious ego relations; cultural anthropology; clinical observations on aphasia and agnosia; practical problems in psychotherapy; general linguistics; general semantics; and such applications as education techniques and the psychology of advertising and of propaganda.

Unfortunately, space permits only a very brief and basic discussion of the topic. Moreover, it seems desirable to postpone the discussion until the topic of the orienting reflex will have been considered. Still, we might mention here that current Russian psychophysiology, quoting Pavlov, accords a *sui*

generis status to verbal conditioning in general, regarding it as not merely a case of simple second-order conditioning but as a special higher level "signal-of-signals" CR basis of abstraction of high level generalization. That a word is by its very nature an abstraction, a statement found in Pavlov's writings, is taken very seriously in both its genetic and its ontological aspects as a problem fit for both experimental analysis and clinical research.

THE ORIENTING REFLEX

Historical Background

The conditioned stimuli—the sounds of bells, buzzers, whistles, metronomes, etc.; the flashes of lights and the sights of rotating whirligigs and other objects, etc.; the rhythmical scratchings and touchings, etc.; the different thermal stimulations; and the various odors —which Pavlov used to condition the food reactions, and later also the defense reactions, of his dogs were what we call sensory stimuli: that is, stimuli that are accompanied in human subjects by sensory experience, indeed, that *are* the body-material of almost all our ordinary experience. Pavlov, however, was no more concerned with the stimuli's preconditioning sensory experiences than with their postconditioning image experiences—both sensations and images were left in limbo in 1902 when he decided to abandon the term psychic (notably, psychic secretion used by him since 1886) for that of conditioned. Still, the stimuli evoked in the dogs some overt, though often not very pronounced, reactions, and these reactions Pavlov named the "orienting" or the "what-is-it" or the "investigatory" or the "attitudinal" (in Russian, *ustanovychny*) reflex, using the particular names nondifferentially. The stimuli themselves Pavlov called "indifferent stimuli," added evidence that he did not accord their original preconditioned reactions any particular per se significance in his system.

Later on, in the laboratory, Pavlov noted that conditioning proceeded best when the orienting reflex (for convenience, it will be abbreviated as OR) is neither too large nor minimal or absent, and that in the course of CR training the OR tends to disappear—characteristics that might have been correlated with conscious experience by saying, for instance, that the conditioned stimuli must arouse adequate but not overwhelming consciousness and that consciousness tends to disappear as habit develops. But, again, such formulations became, after 1902, wholly alien to Pavlov. Dedicating his entire program of experimentation to, we might say, an isomorphic study of two Cs, the Cortex and Conditioning, he had no use for the isomorphism of the third C, that of Cognition or Consciousness. And, although less radical with respect to the general status of consciousness than early American behaviorists and, unlike them, in no way involved in any attempt to "explain it away," he, nonetheless, was very militant about its invalid methodology. Years before the rise of American behaviorism, in 1904, Pavlov stated that "one must renounce completely psychological formulations and remain standing upon a purely objective ground" (Pavlov, 1928, p. 75; 1949a, Vol. 3, p. 51). And in 1910 he wrote:

> Why had we formerly, like cowards, embraced the subjective method? . . . The subjective method is a method of causeless thinking, psychological reasoning is indeterminate reasoning, recognizing phenomena but not knowing whether they come from here or there. To be content with saying "the dog thought," "the dog wishes" is a fiction, not a disclosure of the cause of the phenomenon. Our [former] psychological explanations were fictitious and groundless. Our [present] objective explanation is truly sci-

entific, always turning to causes, always seeking causes (Pavlov, 1928, p. 165; 1949a, Vol. 3, p. 138).

This total Pavlovian rejection of psychology and of special psychological cognitive-perceptual problems continued for a number of years after Pavlov's death (1936). In time, however, changes occurred in the wake of special problems, new techniques, and modified general points of view. The special problems which contributed to the extension of Pavlovianism to the cognitive-perceptual dimension fall, interestingly, into two contrasting categories: those dealing with predominantly conscious reactions and emphasizing the dimension directly, and those dealing with unconscious ones and emphasizing it by contrast. The extensive and very successful investigations of the Lazarev-Kravkov school of sensory interactions (Razran, 1958, p. 1187), the highly original Makarov experiments (1950a, 1950b, 1952) on interoceptive sensibility, and the aforementioned studies of verbal-semantic conditioning are the outstanding examples of the first category of special problems. Gershuni's experiments (1947, 1955, 1957a, 1957b; Gershuni, Klass, Lukomskaya, Linyuchev, & Segal, 1959) on subliminal auditory conditioning and Pshonik's (1949a, 1949b, 1949c, 1952) on subliminal thermal conditioning, as well as the entire area of interoceptive conditioning, are cases of the second category of problems.

Again, post-Pavlovian CR and UR techniques and methodologies began to move rapidly from what might be called a "monoeffector" to what the Russians call a "polyeffector" stage. That is to say, as may be judged from what has been said so far, the old Pavlov and Bekhterev way of measuring changes in reactivity and conditionability in only one effector such as salivation or paw-withdrawal was replaced by simultaneous recordings of changes in a wide, almost an all-possible, variety of effectors, a state of affairs which almost automatically inducted series of correlations among differing indices of organismic change, and thus also of correlations with the cognitive index. Indeed, in very recent years Russian psychophysiologists have even resorted to such traditional devices as correlating subjects' rankings of stimulations and stimulation changes with objective pointer readings. And spectacular Russian engineering advances multiplied of course the number of possible pointer readings of psychophysiological processes.

Finally, with respect to modified points of view and cognition, one should mention that Pavlov's immediate successor, the late L. A. Orbeli, was a student of the German psychophysicist Hering; that J. S. Beritov (Beritashvili) became much interested in what he called "psychonervous behavior" in his later experiments; and that K. M. Bykov, P. K. Anokhin, and E. A. Asratyan have in general been friendly to psychological approaches and have tended to introduce some innovations in the Pavlovian system (the last two more than the first). And last, but by no means least, there is the fact of the rapprochements between psychophysiology and psychology since 1950—rather, the since-1950 Pavlovianization of psychology—and the deeper penetration of Marxism-Leninism and its emphasis on the emergent efficacy of consciousness, which Pavlov resisted but which his successors could not or would not resist in the same way.

Just how the Russian psychophysiologists' experimental interest in problems of cognition and perception has become, and is continuing to become, closely connected with experimental problems of the orienting reflex is the

subject of the last section of the present article. Suffice it to say here only that a recent Russian book, *Perception and the Conditioned Reflex* (Sokolov, 1958c), might as well, and indeed more appropriately, have been named "The Orienting Reflex and the Conditioned Reflex" or "The Orienting Reflex, Perception, and the Conditioned Reflex."

Characteristics

Two collections of experiments wholly devoted to the study of the OR appeared in the Soviet Union recently, one in 1958 and one in 1959. The 1958 collection, entitled *The Orienting Reflex and Orienting-Investigatory Activity* (Voronin, Leont'yev, Luria, Sokolov, & Vinogradova, 1958), consists of 48 reports of experiments divided into six parts: General Problems; the Orienting Reflex and Problems of Reception (Perception); the Phylogeny of the Orienting Reflex; Its Ontogeny, Pathology, and Special Problems in Man. The 1959 collection, named *The Orienting Reflex and Problems of Higher Nervous Activity* (Sokolov, 1959a), comprises only 14 experiments but is nonetheless quite comprehensive; it contains, for instance, a total of 116 figures and a bibliography of 385 titles. And to these 62 OR experiments, should be added at least as many that have been reported in the periodical literature, mostly in the last 5–6 years. There is thus no doubt that the OR is a prime focusing center in current Soviet psychophysiological and psychological research and thought, particularly if one remembers that its experiments purport to provide not only new information but a new look at old information: that is, the OR is put forward as a new concept, although, as will be seen later, in a number of aspects it is really only a renovated one and in some respects it is one that under different names is not at all new to American and Western students of behavior.

The total material of the OR, unlike that of interoceptive and semantic conditioning, does not lend itself readily to summing up and discussing through sample experiments. A better way of presenting it would seem to be an unfolding enumeration and discussion of experimentally established and indicated OR characteristics. Six sets of such characteristics will be considered:

Reactional primacy and holistic specificity. The OR is the organism's normal first reaction to any adequate normal stimulus or, in terms of the stimulus, it is the organism's normal reaction to a normal *novel* stimulus. Novelty does not mean no previous presentations of the stimulus but merely that the stimulus possesses the OR evoking novelty for only a limited number of presentations—the exact number depending upon a variety of parameters to be discussed later—after which the stimulus either evokes no reaction at

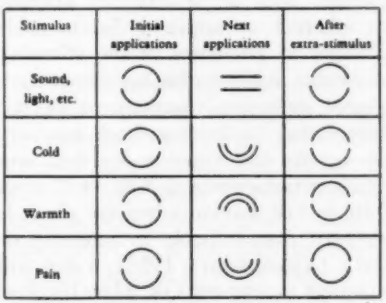

FIG. 32. Vasomotor pattern of the orienting reflex in human subjects. (Concave arc above convex arc—constriction of digital blood vessels plus dilatation of forehead blood vessels; double line—no observable vascular change in either digital or forehead blood vessels; two concave arcs—constriction of both digital and forehead blood vessels; two convex arcs—dilatation of both digital and forehead blood vessels.) (Reproduced from the *British Journal of Psychology* by permission)

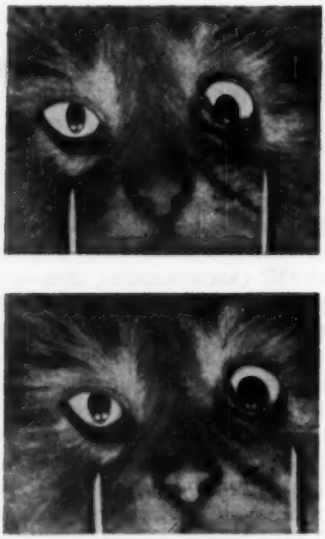

FIG. 33. Pupillary dilatation to sound in cats as part of the orienting reflex. (Left eye is sympathectomized.)

all or a reaction that is different from an OR. And novelty includes also change, that is, it extends liberally to inherent or acquired discriminable changes in attributes of the stimulus. A human subject who has shown consistent defensive reactions to electric stimulation (unless the shock was very strong, its first reaction—or first several reactions—was an OR) will react fully in OR fashion when the shock is changed discriminably in intensity or locus (Vinogradova, 1958), a dog will manifest a clear-cut OR when his food is changed in kind (Anokhin, 1958, p. 17), and a rabbit fully accustomed to a hammock as a vivarium will resume all old OR action upon shock administration (Anokhin, 1958, p. 15).

The OR is in no sense a single reflex but is in all respects a centrally organized, holistic system of a variety of specifically distinguishable visceral, somatic, cognitive, neural, and neuromotor reactions (Sokolov, 1958c). The specificity of the OR reactions pertains to kind, amplitude, latency, and general pattern, and the Russians have been working at full speed to detect and ascertain each distinctness experimentally. At least in human subjects, they seem to have clearly established, as was already indicated earlier, that the dilatation of the blood vessels of the forehead accompanied by the constriction of the digital blood vessels is an OR reaction and only an OR one (Vinogradova, 1958, 1959a, 1959b; Vinogradova & Eysler, 1959; Vinogradova & Sokolov, 1955). Figure 32 (Luria & Vinogradova, 1959), based upon data of a large number of experiments and subjects, illustrates fully this vascular distinctness of the OR in response to stimuli of all modalities, and shows as well the reactional primacy of the OR, its modifiability through repetition, and its reappearance in novel settings. The Russians have also experimented extensively with pupillary dilatation as an OR component. Their data show dilatation to be almost invariably the first reaction to nonvisual stimuli and to occur in about 20% of first reactions to visual stimulations; the 80% of pupil constriction to visual stimuli are interpreted as cases of inhibition of the dilatative OR reaction by the constrictive local-adaptive reflex (Liberman, 1958; Shakhnovich, 1958).

Likewise, the galvanic skin reflex, electroencephalographic desynchronizations, a variety of respiratory changes, and special oculomotor, digital, manual, pedal, and general bodily motor and proprioceptive reactions are being studied carefully and delimited as OR components. Figure 33 (Shakhnovich, 1958, p. 197) shows an OR dilatation of the pupils of a cat's eyes in response to sound, with the muscles of the left iris sympathectomized, and Figure 34 is an oculomotor chart of a subject

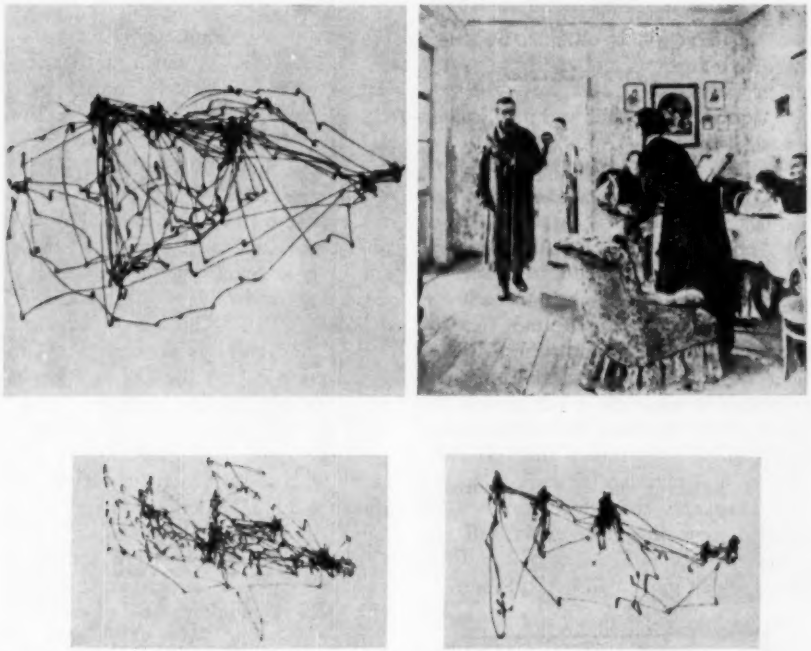

FIG. 34. Eye movement chart of a subject watching painting *"Nye Zhdali"* [They Did Not Expect Him] by Repin for 10 minutes under three conditions. (Left—uninstructed; lower left—told to think what family was doing when the visitor arrived; lower right—told to estimate ages of members of family.)

looking at a Repin painting *"Nye Zhdali"* [They Did Not Expect Him] under three conditions: without instructions, thinking of what the family was doing when the visitor arrived, and estimating ages of members of the family. Figure 35 (Bronshteyn, Itina, Kamenetskaya, & Sitova, 1958, p. 239) is a record of cessation of respiration in a 72-hour-old human neonate in response to stimulation with a light, which, too, is held to be a specific OR component (non-OR respiratory changes are allegedly characterized not by cessation but by alterations of amplitude, frequency, and pattern). Characteristic stimuli produced cessations of reactions must in general, it is argued, be placed alongside evocations of reactions in determining OR patterns—e.g., the "listening to" of birds and mammals and the "frozen-in-thought" states of apes and children during the solving of problems (Dolin, Zborovskaya, & Zamakhover, 1958). And of course there is in the fully developed OR the specific molar reaction of "turning towards the source of stimulation," a reaction which the author

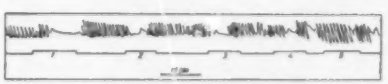

FIG. 35. Respiratory change in human neonate 72 hours after birth, upon stimulation with lights, as part of the orienting reflex. (Note extinction of response after four trials.)

would like to name versive, with a note that this reaction is outside the much used dichotomy of approaching-avoiding or adient-abient reactions—the versive reaction is neither and may indeed precede either.

On the other hand, it should be noted that the OR is specific only to the novelty and change characteristics of the stimuli that evoke it but not to their intrinsic nature, and that in general it might be said that, unlike the alimentary or defensive or sexual reaction patterns of the organism, the OR pattern does not really "manage" the stimuli that come to it but merely reacts to their presence, its reactions thus being more preparatory than consummatory and preadaptive than adaptive. Yet these very characteristics impart a general controlling role to the OR and a function not unlike that of cognition, about which more will be said later.

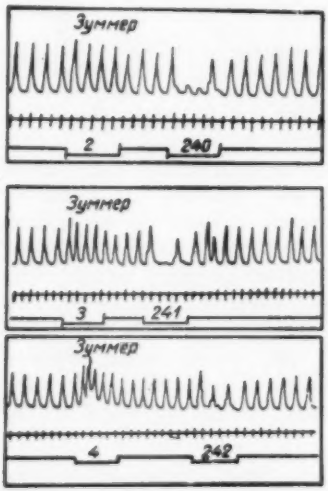

FIG. 36. Persistent (highly resistant to extinction) respiratory reaction of a hare to a rustling sound, and the conditioning of this reaction to the sound of a buzzer. (Lines from above: respiration, time in seconds, application of buzzer and of rustling sound. Numbers denote ordinal trials.)

Evolutionary, ecological, and pathological aspects. Phyletically, the lowest animals the ORs of which the Russians have studied are fish (Chumak, 1958; Gusel'nokov, 1958; Vedyayev & Karmanova, 1958), and it was already mentioned that the Russians hold that in human ontogeny ORs are present right after birth. However, they have also reported near-absence of ORs in the early ontogeny of such animals as dogs, cats, and rabbits (Chumak, 1955; Nikitina, 1954; Nikitina & Novikova, 1958), and there is no doubt that the assumption is that the OR is a phyletically recent reaction pattern. And it is of course a pattern that manifests the greatest amount of evolutionary plasticity with respect to type, variety, and duration of its reactions (Dolin et al., 1958; Vedyayev & Karmanova, 1958). Clear-cut differences were found, for instance, in one experiment between the ORs of monkeys and of dogs, the former showing invariably more and longer lasting reactions and in addition a much greater ratio of somatic to visceral components (Nikitina & Novikova, 1958). And similar results were obtained in comparing the ORs in the first months of normal and of prematurely born children (Polikanina & Probatova, 1955, 1958; Voronin et al., 1958), and in age-specific comparisons of infants (Karlova, 1959) and of baby rats, rabbits, dogs, and monkeys (Volokhov, Nikitina, & Novikova, 1959). Yet, with respect to effectiveness of stimuli that evoke ORs, differences between animals appear to be often more a matter of ecological than of purely phyletic factors. Rustling sounds which are very weak OR stimuli in dogs are very powerful ones with hares. Figure 36 (Klimova, 1958, p. 79) shows that 240 applications of a rustling sound failed to extinguish completely a hare's respiratory OR changes to it, and that furthermore the sound of a buzzer

which originally was ineffective became conditioned to the rustle reaction in three trials. Other specific and particularly effective OR evoking stimuli were found to be: the sight of a cat for owls, the odor of rosemary and hunters' decoy sounds for ducks, the displacements of objects in the field of vision and sucking sounds for hares, the sound of wood splintering for beavers, and the sound of waves splashing for fish (Klimova, 1958, p. 77). While it is possible that some of the effectiveness of the particular stimuli was due to "natural" pre-experimental reinforcements, the consistency of the results and the fact that young animals were used in some cases point to congenital ecological differences.

The relation of the OR to human pathology is evident in the difficulty of arousing it in schizophrenic and head injured patients and in feebleminded children. Figure 37 (Gamburg, 1958, pp. 273, 277) demonstrates that a concealed sound (experimenter does not state its nature) which evoked consistent OR somatic and visceral reaction patterns in 29 of 34 healthy subjects, aroused the pattern in only 4 of 42 schizophrenic and in 2 of 28 head injured patients. (As may be seen in the figure, the 5 remaining healthy subjects and the 26 remaining head injured patients responded to the stimulus with defensive reactions, while 15 of the schizophrenics reacted defensively and 23 did not react at all.) Figure 38 (Dolin et al., 1958, p. 57) shows that the sound of a buzzer produced a vascular change in a schizophrenic patient only on the eighth presentation. The results with feebleminded children, compared with normal ones, run in the same direction. In one experiment, all 20 normal children manifested vascular OR reactions to the flash of a light, the sound of a metronome, and the sound of spoken words, but of 40 feebleminded children, only 20, 31, and 35 reacted so to the three respective stimuli (Vinogradova, 1959b, p. 172). Similarly, in another experiment, with 12 feebleminded children and the use of pure tones as stimuli, it was found that one child produced a psychogalvanic OR reaction only on the fifth presenta-

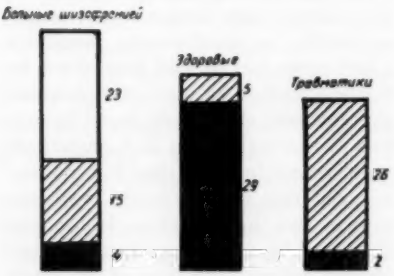

FIG. 37. First reactions of 42 schizophrenics, 28 head injured patients, and 34 normal subjects to equal auditory stimulation. (Blackened area, orienting reflex pattern; diagonal-line area, defensive pattern of reactions; clear area, no reactions. Left bar, schizophrenics; middle bar, normal; right bar, head injured. Numbers of subjects showing each reaction pattern are indicated to the right of the bars.)

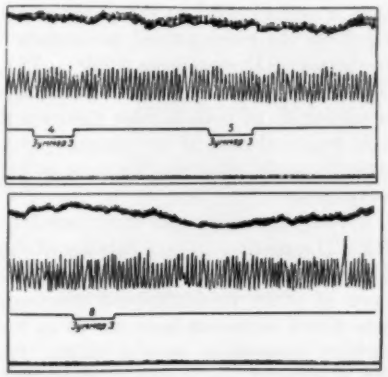

Fig. 38. Absence of vascular and respiratory reactions of a schizophrenic patient to the sound of a buzzer and the appearance of a vascular change only on the eighth stimulation. (No data are given on the first appearance of the respiratory reaction.)

tion, a second child on the ninth, and a third on the twenty-third presentation of the tone (Paramanova, 1959, p. 78). This disruption of the OR in pathology is obviously of considerable theoretical and practical-clinical significance; but, unfortunately, evidence for it is as yet very meager.

Extinguishability and transformability. The ready extinguishability of the OR in dogs in contrast to the persistence of other unconditioned reactions was noted early—at least as far as reactions observable to the naked eye are concerned—in Pavlov's laboratory. Pavlov himself stated that the extinction of the OR "is analogous in details to the extinction of conditioned reflexes" (Pavlov, 1927, p. 256; 1949a, Vol. 4, p. 269) and that "this reflex has points of applications [representations] in both the cortex and the lower-lying regions of the brain" (*ibid.*), and later Orbeli (1949) declared: *"There exist reflexes* [in reference to the OR] *that are innate in origin yet function fully as acquired reactions"* (p. 736). And while present-day data suggest the need of qualifying considerably the generalization of the ready extinguishability of the OR with respect to some stimuli, reactions, and subjects, the same qualification applies equally to the extinguishability of the CR which, too, may be very difficult with largely similar types of stimuli, reactions, and subjects. In other words, Pavlov's original statement about the extinction similarity of the OR and the CR—and we might add also, as will be seen later, his view of the combined cortical-subcortical neural basis of the OR—is in the main still quite valid, although one might well argue with Orbeli and say that extinction similarity of reactions does not mean total functional similarity.

The main indicated parameters of OR extinguishability are: (*a*) direct relationships with the phyletic position of the subjects (Obraztsova, Pomazanskaya, Stel'mach, & Troshikhin, 1958, p. 251; Vedyayev & Karmanova, 1958, p. 204) and the phyletic recency of the specific OR component (Sokolov, 1958b, p. 113)—animals higher in the phyletic scale extinguish their ORs more readily, and the PGR component of the OR extinguishes much more quickly than the respiratory component; (*b*) inverse relationships with intensity of the OR stimulus (Petelina, 1958), amount of brain extirpation in animals (Karamyan, 1958), and organic and functional psychopathology in human subjects (Lichko, 1952; Sokolov, 1959b, p. 48; Usov, 1952)—lesser extinguishability in each of the three cases. And to these should be added: (*c*) the inverse relationship with the ecological significance of the OR stimulus; and (*d*) the unsettled—sometimes direct, sometimes inverse—relationship with intelligence of children as subjects (Polikanina & Probatova, 1958). The first two sets of parameters as well as the fourth parameter operate equally in CR extinguishability (Razran, 1956); while the parameter of ecological significance is not readily applicable to conditioning situations. Little more can be said here about extinction, except for a general statement that our best empirically based hypothesis is that extinction is a phyletically more recent function than is conditioning and that the wholesale bracketing of the two in American laboratories may well be more a matter of experimental convenience than of an empirical and logical cogency.

OR transformability refers to the fact that while, as seen in Figure 32 (the first figure in this section), repeated presentations of some stimuli (and some intensities of stimuli) extinguish the OR, repeated presentations of other stimuli (and other intensities of stim-

uli) transform the OR into another type of reaction (or, we might say, the OR gives way to another type of reaction). So far, quantitative relations have been worked out only with respect to the transformation of the OR into a defensive reaction, when 20 repeated applications of each of 20 discriminable shock stimuli were administered to adult human subjects (Sokolov, 1958c, p. 64). The criterion of the appearance of the OR was a *disparate* vascular reaction, that is, dilatation of the blood vessels of the forehead plus the constriction of the digital blood vessels; the criterion of the defense reaction was a *conjoint* vascular reaction, that is, constriction of both the digital and the forehead blood vessels. The experiment was performed by E. N. Sokolov, by all tokens the most active student of the topic, and the data are all presented in Figure 39. As may be seen from the figure, the OR first appeared at 2 units of shock but disappeared after the first trial; at 4 units the disappearance took 6 trials, at 6 it took 13 trials, but at 7 units a defense reaction emerged after 17 trials, while at 13 units the defense reaction came after 6 trials, and at 17 units of shock the first reaction was defensive. Quantitative findings on the transformation of the OR into other types of reaction have to date not been reported, but are of course very much needed.

Conditionability and reinforceability. That ORs which are difficult to extinguish could act as URs and be readily conditioned to other stimuli was demonstrated, it will be remembered, by the case of the hare whose respiratory OR to a rustling sound was conditioned to a previously inadequate sound of a buzzer (Figure 36). However, even more normal and quickly extinguished ORs could be thus effective. Children's turning to the source of a flash of light could be conditioned to a preceding sound provided the latter is not too loud (Karlova, 1959; Lebedinskaya, 1958; Kasatkin, Mirzoyants, & Khokhitiva, 1953; Mirozyants, 1954), and conversely dogs' or apes' turning to a sound of a buzzer has been known to become conditioned to a preceding change in illumination (Rokotova, 1952). Indeed, it is the contention of Soviet experimenters that all sensory preconditioning or what the Russians call associative conditioning is mediated through OR conditioning (Anokhin, 1958, p. 18; Voronin, 1957, pp. 99–103), while according to Anokhin (1958) and to Polezhayev (1958, 1960) the OR operates in all conventional (food or shock) classical conditioning to complex stimuli as an afferent and feedback central integrator of the stimuli before their actual conditioning to the peripheral food or shock reaction. Moreover, there is the study by Vinogradova (1959a) in which the administration of unavoidable electric shocks to human subjects was preceded by sounds of a metronome or of a pure 50-db. 1,024-cps tone and the resultant vascular condi-

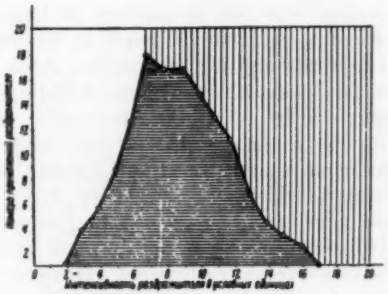

FIG. 39. The transformation of OR vascular patterns upon electrical stimulation into defensive ones as a function of the intensity of stimulus and the number of repetitions. (Clear area, no reaction; horizontal-line area, OR pattern; vertical-line area, defensive pattern. Abscissa, intensity of stimulus; ordinate, number of repetitions.)

tioning was for a number of trials orienting and not defensive in nature (disparate and not conjoint). Anokhin's views and Vinogradova's findings are clearly of special relevance to American theories of learning which maintain that classical conditioning is a central, sensory, anticipatory, or expectancy event (Woodworth, Tolman, Hilgard), insofar as the OR may well be conceived in such terms. However, the Anokhin-Vinogradova claims extend only to the OR as an intervening preparatory-guiding aid in conditioning, and not as its final idiopathic mechanism.

The reinforceability of the OR refers to the feasibility of strengthening it through some subsequent event in the manner of operant conditioning (though the OR could not readily be conceived of as an operant). Two kinds of experiments are available as evidence. In one, fox cubs were brought to the laboratory to listen to squeaks of mice. The squeaks evoked in the young animals clear ORs which, however, extinguished rather quickly upon repetition. Yet when the cubs were permitted to eat the mice, one meal sufficed to make the OR to the squeaks almost unextinguishable (Biryukov, 1958, p. 24). In the other kind of studies, weakened ORs of human subjects to auditory sensory and verbal stimuli became very much strengthened when the subjects were told that they had to do something such as push a button, count the beats of the metronomes or the letters of the words, etc. when they heard the stimuli—that is, when the stimuli were "functionalized" or "signalized" (Russian term) in a simple "voluntary" reaction time design (Sokolov, 1958c).

Moreover, as has already been indicated in the preceding paragraph, reinforcement of CS evoked ORs continues for some time even in typical classical CR designs. Indeed, it might even be argued that the commonly noted final reduction of the OR in classical conditioning is not unrelated to the loss in rate of CR elicitation in operant conditioning when reinforcement is continuous (100%)—a matter which raises the whole problem of the relation of the two types of CR modifications and which, together with other more general problems of theory, will be discussed in the final section of this article.

Cortical-subcortical basis—vigilance versus investigation. Pavlov's view that the OR is rooted in both the cortex and the subcortex is being supported by a number of—although as yet still few—experiments on the effects of brain extirpation and specific drugs on OR manifestations. The fact is of course that the very conception of the OR as involving the psychogalvanic reflex (see Schwartz' experiment, 1936, 1937, on the relation of Cortex Area 6 to its elicitation), the desynchronization of alpha rhythm, and molar-versive reactions, on the one hand, and pupillary, respiratory, oculomotor, vascular reactions, on the other, means a cortex-subcortex neural expanse—and Pavlov's perspicacity in the matter can only be applauded. In addition, there have been recent attempts by Anokhin as well as by Sokolov to relate the OR *also* to the action of the reticular formation (Anokhin, 1958, p. 15; Sokolov, 1958b, p. 112). Figure 40 (Lagutina, 1958, p. 84) is a localization map of the OR in the brains of 28 cats and 4 apes, obtained by Lagutina with the use of implanted electrodes. The animals were moving freely in the experimental room, and the electrode stimulations of the points marked on the map produced typical ORs of head turning, pupillary dilatation, respiratory and vascular changes, as well as exploratory and manipulative reactions.

As may be seen from the figure,

Lagutina divides the evoked ORs into "general vigilance" and "investigatory" types. Other experimenters have sometimes distinguished between "what-is-it" and "what-to-do" ORs (Kvasov, 1956) or between generalized and specified ones (Sokolov, 1958a, p. 171) or assumed separate orienting and investigatory reflexes or preadaptive and adaptive ones (Bykov, 1958). As yet, however, these divisions and distinctions are far from experimental validation or even clear delineation and are fraught with the difficulty that adaptive and specified reactions are normally integral parts of nutritive, defensive, sexual-reproductive, and other non-OR reaction patterns. Hence, at least for the time being, the reviewer would favor subsuming under the OR only reactions that, it might be said, "hold" but do not "manage" stimuli—thus including investigatory-exploratory reactions but not adaptive-specified ones.

Cognitivity. Discussion of the cognitive nature of innate behavior patterns in animals—for that matter, also of acquired patterns—must obviously relate to indirect arguments and assumptions, and be more than a mere analysis of experimental data. Yet, there is little doubt that if any such pattern is accorded cognitive status, the OR pattern is surely the most likely candidate. Consider the indications of its relatively recent phyletic emergence and its dependence upon the relatively newer regions of the encephalon and of encephalization, its high evolutionary plasticity in both phylogeny and ontogeny, its ready functional lability and modifiability, its disruption in human organic and functional psychopathology, its central organized unity and cohesiveness coupled with its peripheral variety of reactions and, notably, its general function as a preparatory and controlling mechanism of what is to come. Moreover, in human subjects

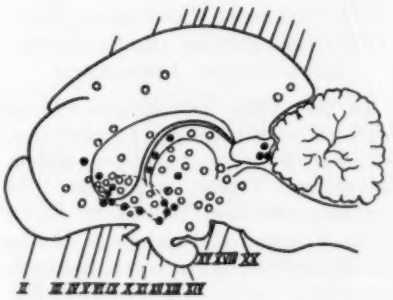

FIG. 40. Localization map of ORs in the brains of 28 cats and 4 apes, with the use of implanted electrodes. (Dots indicate stimulation points which evoked ORs of the "vigilance" type; circles, ORs of the "investigatory" type.)

there is also considerable evidence to show that the elicitation of the OR is paralleled by a significant decrease in thresholds of conscious sensitivities (Sokolov, 1958a) and that, in general, positive correlations may be found between the scope and duration of elicited ORs and the scope and duration of conscious experiences (Asafov, 1958; Mikhalevskaya, 1958; Sokolov, 1958a, pp. 170–182; 1958c, pp. 7–38). To be sure, there is also evidence that ORs may operate in human subjects without awareness, particularly in interoceptive stimulations (Mysyashchikova, 1952). However, on the one hand, it is by no means claimed that cognition is a *sine qua non* of OR action but only that fully developed ORs are cognitive, or that cognition "emerges" from the OR as "the material basis." And, on the other hand, as was already indicated, Russian theoreticians are quite friendly to the view of *unbewusste Bewusstseinslagen* and have always been avowed adherents of the concept of levels. Hence, there may well be: reactions without ORs, ORs without cognition, cognition without awareness, and, for that matter, levels of "awarenesses."

THE INFERABLE CONSCIOUS: THE ORIENTING REFLEX AND SEMANTIC CONDITIONING JUXTAPOSED

In the 1956 authoritative Soviet textbook of psychology, *Psikhologiya*, edited by Smirnov, Leont'yev, Rubinshteyn, and Teplov, and in the 1959 *Psikhologicheskaya Nauka v SSSR* [The Science of Psychology in the USSR], edited by Anan'yev, Kostyuk, Leont'yev, Luria, Menchinskaya, Rubinshteyn, Smirnov, Teplov, and Shemyakin, the now familiar distinction is drawn between the psyche (Russian *psikhika* and *psikhichesky* are on the whole better translated literally even if in a number of contexts "mind" and "mental" sound more English) and consciousness, the former including both conscious and unconscious psychic processes and the latter comprising only the conscious or aware ones. And another, in a way specially Soviet, emphasis is laid on the vast qualitative difference in level and complexity between the human and the animal psyche, the former alone possessing the enormous advantage of the second signal (language) system developed in the course of work and tool using as a means of changing, and not merely adjusting to, the environment. The experiments on both the orienting reflex and semantic conditioning may obviously be interpreted—and indeed are interpreted—as illustrations of these theoretical statements, the OR as an example of the early phylogenetic adjustive *animal* psyche and semantic conditioning as a high level manifestation of the ontogenetically fully developed *human* psyche (it is not assumed that the animal psyche wholly disappears within the human one but only that it becomes transformed, or merely that the two coexist). And both types of experiments, it might further be said, stress the psyche as a controlling mechanism and study it mostly indirectly and physicalistically (or behaviorally). Or, to use the expression of the beginning of this article, both types of experiments deal with the Inferable Conscious "whether it is or is not observable."

A behavioral or physicalistic study of the psyche (mind) and the concept of the Inferable Conscious are of course by no means new or special to Soviet psychophysiology and psychology. American and Western behavioral scientists have surely used the approach for some time, the system of Tolman being perhaps the purest example of it. However, what is significant here is that Soviet scientists appear to be adopting this approach as a sort of synthesis between a Pavlovian methodology and a Marxist-Leninist ontology, and what is even more important is the concentrated cumulation of so many pertinent and ingenious experiments under its egis. Moreover, there are really a number of cardinal differences between, let us say, Tolman's and the Russians' views.

For one thing, as was already indicated, the Russians stress strongly the qualitative distinctness of the human psyche in its special development in the qualitatively distinct second signal system, whereas, according to Tolman, the behavior—we might add, the cognitive behavior—of a rat at choice points in a maze epitomizes almost all basic aspects of psychology.

For another, the Russians are much more involved in studies of minute or molecular behavior and of neurophysiology and in general are much concerned with expanding the realms of observable behavior at all levels rather than with conceptualization at one level and its testing and application at others.

A third difference stems from the consideration that, while at the conscious level present-day Russian stu-

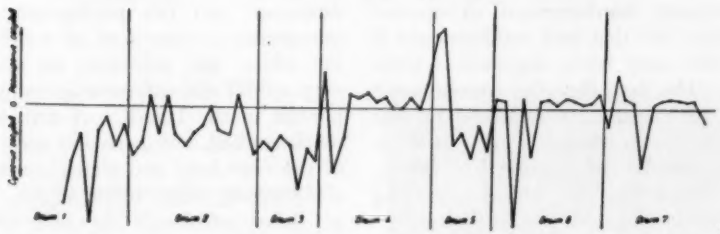

FIG. 41. Transformation of digital vasoconstriction into vasodilatation to electrical stimulation when human subjects were permitted to watch their plethysmographic records and note that dilatation reactions were followed by shock termination.

dents of behavior eschew no psychological category, are much interested in psychic (cognitive) controls, and even resort to direct subjective observations of experience, at the unconscious level they assume nonpsychic material neurobehavioral forces and mechanisms to be largely in full control. In Soviet theory, the psyche is an emergent and is not coextensive with all bodily action (there is quite a touch of Cartesianism in Soviet philosophy).

Fourthly, there is the fact of the Russians' wholesale rejection of the views of gestalt psychology and of Freud, the concept-models which Tolman uses so profusely (sign gestalt, need cathexis, etc.). Present-day Soviet holism is mainly associationistic, related traditionally to Wundt's "creative synthesis," Ehrenfels' *"Gestaltqualität,"* and Pavlov's statement that "associations generate [and govern] *Gestalten* and not *Gestalten* . . . associations" (Pavlov, 1936; 1949b, Vol. 3, p. 46). And, while Soviet psychophysiologists and psychologists grant some status and force to unconscious psychic mechanisms, they are by no means willing to accord these mechanisms Freudian ubiquity and potency—and contents. Finally, there are also significant differences between typical American-Western and Soviet formulations with respect to social aspects of the psyche and behavior, the Russians postulating as a rule the existence of a special social or collective consciousness. Space forbids further discussion of the topic.

One striking Russian experiment on psychic or cognitive control will, however, be cited in conclusion. Five adult human subjects were subjected to rather prolonged and moderately painful electrical stimulations while photoplethysmographic records were taken of changes in the volume of the blood vessels of their arms. As known, such stimulations produce vasoconstriction. However, occasionally and infrequently instances of vasodilatation also occurred in the experiment and when they did the experiment was rigged to terminate the shock, producing, in terms of B. F. Skinner, negative reinforcement. Yet no changes were evident in the subjects' records despite 80 reinforcements. The experimenter then let the subjects watch their records while being stimulated, from which they quickly learned the connection between the vasodilatation and shock termination. And here, as may be seen in Figure 41, a vasomotor transformation from constriction to dilatation was effected in the course of several experimental sessions (Lisina, 1958, p. 341).

In terms of current American psychology, the experiment offers two key findings: that, contrary to assertions, autonomic reactions can be modified by

subsequent reinforcement in operant fashion; and that such reinforcement is effective only when cognition is present. The fact that the cognitive act involved in subjects' watching records of their own reactions may well be quite complex, accompanied by behavior differentials, and subject to varying interpretations does not, in the reviewer's opinion, detract from the obvious systematic significance of the results. Nor should the significance of the results be derogated by the consideration that they are no doubt quite specific—are not likely to hold (indeed do not hold) in operant modifications of skeletal reactions, and may well not extend in full to operant modifications of other autonomic reactions. Experimental pioneering is an inductive enterprise.

OVERVIEW

Related Areas

Interoceptive conditioning, semantic conditioning, and the orienting reflex are no doubt core areas of current Soviet psychophysiological research, and what has been said thus far has highlighted, it is hoped, considerably the main contours of their empirics and special theory. However, to subsume the three areas under one integrated framework and make it more representative of the topography of the entire field it will be necessary to consider briefly the essence of Soviet basic research in several other related areas such as: (*a*) proprioceptive and what we call (but the Russians do not) operant or instrumental conditioning; (*b*) compound, pattern, systematized, stereotype, and what the reviewer has called configural conditioning; (*c*) verbal conditioning in general, that is, unanalyzed into semantic and phonetographic aspects, the number of studies of which is, as might be expected, many times larger than that of semantic conditioning; and (*d*) phylogenetic and ontogenetic comparisons of conditioning which, too, constitute an area of very special and intensive investigative pursuit in the USSR. A fifth basic, much studied, and pertinent area, that of the neurology and pharmacology of conditioning, has, unfortunately, not yet been sufficiently digested by the reviewer, to permit here even a brief consideration of its essence.

Proprioceptive and operant conditioning. In a pioneer and classic experiment, Krasnogorsky demonstrated in 1911 that passive flexion of the talocrural or of the metatarsal joint of a dog's left-hind paw could become a conditioned stimulus for salivation and food seeking movements. The animal's leg above the paw was placed in a cast while secondary cutaneous stimulation was ruled out through differential conditioning as well as by the fact that the flexion CR was retained after ablation of the animal's ectosylvian and coronary gyri, an operation which, Russian experimenters attest, eliminates cutaneous CRs from extremities. The flexion CR appeared on the twenty-third CS-US combination and at first was generalized to the flexion of the same joint of the right-hind paw. Later on, however, the experimenter succeeded in extinguishing the CR to the flexion of the talocrural joint while forming a CR to the flexion of the metatarsal joint of the same paw (after 74 respective nonreinforcements and 42 reinforcements); and this new CR was differentiated from the flexion of the same joint of the right-hind paw. Another dog, whose right sigmoid gyrus was ablated, was able to form a food CR to the flexion of his right paw, to cutaneous stimulation of his left paw, but not to the flexion of his left paw—thus indicating that this gyrus is involved in the reception of dogs' motor but not cutaneous stimulation, a func-

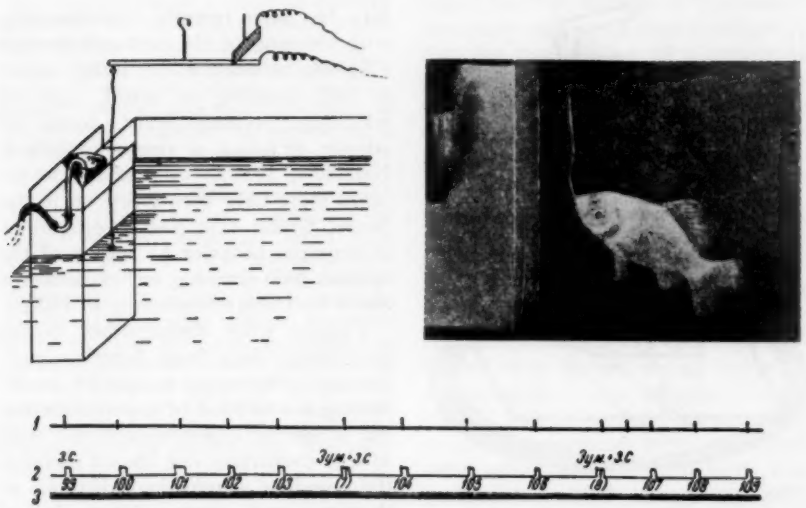

FIG. 42. Discriminated operant food conditioning in fish with a pulling-at-a-suspended-bead technique. (Food is delivered through funnel when bead is pulled, fish pulls when a green light is flashed. 1—kymographic record of pull; 2—application of CS (discriminated operant); 3—time in seconds; зс—green light; зум + зс—buzzer plus green light, attempt to establish conditioned inhibition.)

tion reverse from that of the aforementioned ectosylvian and coronary gyri (Krasnogorsky, 1911).

Krasnogorsky's results were weighed heavily by Pavlov as a discovery of the existence—and locus—of a special motor analyzer, and together with the later studies by Miller and Konorski (1928a, 1928b) and by Konorski and Miller (1930, 1932, 1933, 1934a, 1934b, 1936) formed the basis of his article, "The Physiological Mechanism of So-called Voluntary Movements" (Pavlov, 1936). To be sure, Miller and Konorski, unlike Krasnogorsky, were concerned, as is known, with paw flexion not merely as another kind of classical CS but as another type of CR, the animal's own active production of the flexion as a function of type of subsequent reinforcement and as conditionable to antecedent stimulation—that is, with operant conditioning in Skinner's terms and Type II conditioning in Miller and Konorski's own terminology. However, Soviet experimenters follow Pavlov and, unlike American and even Polish students of the field, link together the Krasnogorsky and the Miller and Konorski types of research (Ayrapetyants & Lichkus, 1957; Petrova, 1941; Skipin, 1940, 1941, 1957, 1959).

Moreover, there is surely no scarcity of experimentation of the runway type of operant conditioning in the Soviet Union. Zelyony, as early as 1913, trained rats to run to a feeding box at the sound of F_2 on a tuning pipe, using smoked paper as a runway to obtain objective records of the pattern of the running in conditioning and extinction. Most of the numerous and highly instructive experiments of Beritashvili (Beritov) and of his many Georgian followers are of the running-to-be-fed, or what the Russians call "free movement," kind of conditioning, as is also a considerable portion of animal studies

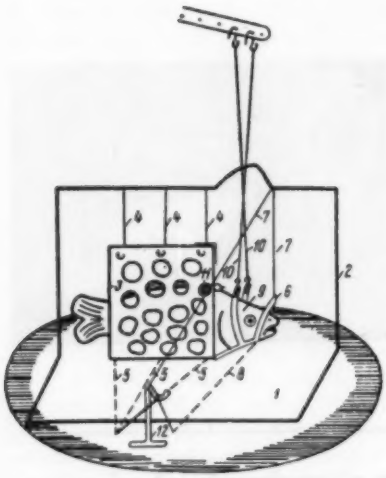

FIG. 43. Apparatus for classical conditioning of fish. (1—base of stand; 2—framework of stand; 3—rubber harness; 4—threads supporting harness; 5—threads moving harness; 6—rubber muzzle; 7—thread supporting muzzle; 8—thread moving muzzle; 9—respiratory cuff; 10—threads connecting cuff with myograph; 11—clamps holding fish in place; 12—anchoring pin for threads.)

of other Soviet CR experimenters, and, incidentally, Pavlov's ill-fated try at CR inheritance. Again, a very extensive series of wholly Skinner-type operant conditioning has been carried on in Voronin's comparative—from fish to chimpanzee—laboratory with the use of a variety of variegated techniques: pulling-at-a-suspended-bead (fish), snapping-at-a-ring (turtles), pecking, lever pressing, drawer opening (birds and mammals), and the like. Figure 42 illustrates the rather interesting pulling-at-a-suspended-bead operant technique used with fish in this laboratory (pull yields calibrated amount of food—Prazdnikova, 1953); while Figure 43 is a diagram of an equally interesting classical CR arrangement with fish (rubber harness, dissolved CO_2 as the US—Chernova, 1953). Indeed, the Voronin laboratory has been recently experimenting with chaining of classical and operant CRs into as many as six links—sound of bell, jumping on stand, sight of whirligig, pressing lever, sound of whistle, grasping of ring (Voronin & Napalkov, 1959). And of course for years there have been going on in the Soviet Union extensive investigations of acquired behavior by means of the operant bulb pressing technique introduced by Ivanov-Smolensky in 1927.

Plainly, what distinguishes Soviet psychophysiology from American psychology with respect to operant conditioning is a lack not of experimentation but of specific conceptualization. And in this connection one should mention the Russians' careful investigations of the comparative cytoarchitectonics of the motor area of the brain, development and differentiation of Area 4, in an evolutionary series of mammals. Roughly, they found the ascending evolution of the development and the differentiation to be: mole, hedgehog, rabbit, rat, horse, pig, badger, bear, tiger, cat, dog, macaque, baboon, orangutang, chimpanzee, and, of course, man (Kukuyev, 1953).

Compound, pattern, systematized, stereotype, and what the reviewer has called configural conditioning. A definition of terms seems to be in order:

> Compound conditioning merely refers to the methodological event in which the CS consists of a group of isolable or isolated stimuli, $a+b+c+d+\ldots+n$, administered either simultaneously or in close succession.
>
> Pattern conditioning denotes the behavioral fact that, first, in simultaneous CS groupings the acquired CR characteristics of a group CS may differ from those of any of its components or combination of components and that, second, in the case of successive CS groupings there may be noted also a CR difference when the same group CS is applied in different temporal sequences. Configural conditioning adds the contention that the component-pattern and pattern-pattern

CR differences are not a matter of algebraic summation but of some configural suprasummative process.

The Russian term "systematized conditioning" or "systematism (*sistemnost'*) in conditioning" means no more than the tendency of CRs to become organized into systems and is thus the equivalent of pattern or of configural conditioning.

On the other hand, their term "stereotype" or "dynamic stereotype" conditioning or simply "dynamic stereotypy" refers to a special temporal system or pattern of CRs, consisting of both positive and negative (differential) CSs applied at equal intervals, and always in the same sequence, which becomes so fixed or systematized that the sequential position and not the specific nature of each CS becomes the main determinant of the animal's specific CS reaction, and which, moreover, may produce an experimental neurosis when the system's fixity is radically disrupted.

Now, even a cursory examination of Russian experimental literature reveals a wealth of experiments on compound conditioning—approximately 600 in number—and the fact that such experimentation was begun almost at the very beginning of the CR era. As early as 1906, data in Pavlov's laboratory showed that some stimuli fail to acquire conditioned properties when they are reinforced only in a compound combination even though they may be readily conditioned through separate reinforcements, and that the failure is an inverse function of the relative intensity of the component CSs (Palladin, 1906; Pereltsvayg, 1907; Zelyony, 1907—cf. Humphrey, 1928). Later, in 1910, results in the same laboratory disclosed: that a compound CS may come to elicit a conditioned reaction even though each of its components has no overt CR value when applied alone, that the generalization of compound CRs is relatively much wider than that of each of its components, and that dogs are able to differentiate among temporal sequences of the same four tones (Babkin, 1910; Zelyony, 1910). Again, in 1912, findings in Bekhterev's laboratory were quite clear in indicating that the conditioning of a compound per se is effected at the expense of a gradual elimination of component conditioning, the weaker components being eliminated first, the stronger last (Platonov, 1912). Finally, in Beritov's (Beritashvili) laboratory a dog was conditioned to each component of a four-link simultaneous compound CS while the combined application of all the components—the compound itself—remained inactive, and four dogs were trained to go to one feeding box when a compound of three or four CSs was applied and to another box when one or more components of the compound were administered (Beritov & Bregadze, 1929, 1930; Bregadze, 1937; Bregadze & Tarugov, 1937).

As indicated earlier, the cited experiments are only chronological paradigms of a very much larger number of studies. Their primary results, since duplicated many times, could not be readily questioned. The results, it needs to be added, support in the main quite solidly Ehrenfels' view of *Gestaltqualität,* Pavlov's already quoted expression that "associations generate [and govern] *Gestalten* and not *Gestalten* . . . associations," and Hebb's concept of *t* in the development of superordination. And there is of course no doubt that methodologically compound conditioning is a virtually unique, most objective, and most genetic means of studying this ever-recurring association-versus-gestalt crux of almost everything basic in psychology. Yet, by all tokens, all these experiments and the empirical wealth of their findings have affected but little American research and thought. Hebb, for instance, does not seem to have been aware of them, and Grings and his collaborators (Grings, 1957; Grings & O'Donnell, 1956; Grings & Shmelev, 1959) ap-

pear to be the only ones to have attempted a duplication of some results. The obvious reason for this neglect, that of the language barrier, needs to be qualified: since some 22 years ago the writer reviewed a few dozen of these Russian experiments (Razran, 1939c) and even added several of his own (Razran, 1938, 1939d, 1939e, 1939f, 1939g, 1940). Perhaps, it is more a matter of a thought barrier, a systemocentricity of one affluent group ignoring the wealth of the other.

Verbal conditioning in general. Aside from interest in isolable semantic conditioning, current Soviet treatment of verbal conditioning in general is, as was already indicated, quite specific and instructive: the Pavlov concept of a "second signal system" and a "signal of signals," with emphasis on the plural form of the last word. That is to say, verbal conditioning in general (language as such) is not just an array of second-order CRs or signals, of which animals are also capable, but is a special higher level human system characterized primarily by being not a signal of one signal, a simple second-order CR, but a signal of *many* signals, a second-order CR to a compound CS—a system that, put somewhat differently, by its very nature, does not merely link and analyze but synthesizes (abstracts or generalizes) its acquired information. The formulation presumably pertains to the complex R and not the simple S aspect of words: that is, to the emergence of the production and use of language and not to its basic character as a stimulus. And it should be noted that, while Pavlov's view of patternization or *Gestaltung* as a CR resultant was based on a long series of experiments—his article on Dynamic Stereotypy appeared in 1932—his conception of verbal conditioning was merely a general statement made in the last years of his life which for a number of years after his death lay almost fallow with hardly any theoretical and experimental analysis. Since 1950, however (The July Joint Session of the USSR Academy of Sciences and the USSR Academy of Medical Sciences Dedicated to the Problems of the Physiological Teachings of Academician I. P. Pavlov), scores of treatises interpreting all aspects of language, its rise and mechanisms and related genetic, experimental, and clinical studies, "in the light of Pavlov's teachings on the second-signal system," have appeared and a good number of special experiments to validate (or test?) what Pavlov said about verbal conditioning have been devised. A recent series of experiments, all by Kol'tsova (1958), might serve as an example of this type of validative evidence:

1. Ten 20-month-old children were shown a doll 1,500 times in the course of several months. With five of the children, the showing was accompanied by the experimenter's saying "Here is a doll," "Take the doll," and "Give me the doll" and the children's corresponding reactions. With the five remaining children, 30 different sayings and corresponding reactions such as "Look for the doll," "Rock the doll," "Feed the doll," "Seat the doll," and the like were used. In all cases each saying was used an equal number of times. After the training, the experimental doll was placed before each child together with different types of dolls and with a number of other toys, and the child was asked to "Pick a doll." The children of the first group selected the experimental doll as well as a number of other toys. Those in the second group selected the experimental doll as well as the other dolls but no other toys. Moreover, the latent period of the "Pick a doll" reaction was almost four times faster for the children in the second group. Presumably, the highly

variegated stimulations-reactions (the much compounded CR) in the children of the second group produced a full-fledged generalization of "doll" and a differentiation from "nondoll," which the much less varied procedure with the children of the first group failed to do.

2. A book was presented 20 times to nine 19-month-old children, divided into three equal groups. In the first group, only one particular book and one particular saying-reaction were used. In the second group, one particular book but 20 different saying-reactions were employed, while the procedure in the third group involved 20 different books combined with only one type of saying-reaction. As in the preceding experiment, the posttraining test consisted of placing before the children the experimental book together with a number of other types of books and with other objects and asking them to "Pick a book." Generalization-differentiation (abstraction) was best in the second group, considerably poorer in the third, and practically nonexistent in the first, thus indicating both the value of compound conditioning and the superiority of motor-kinesthetic over sensory-visual reactions.

3. Twenty-five small objects were presented individually to 10 26-month-old children, divided into two equal groups. In the first group, the presentation of each of 15 objects was accompanied by the experimenter's saying *"veshch'"* [thing, something, object] and delivering a puff of air to the child's eye producing a blink (see Brackhill in the March 1960 issue of the *American Psychologist* for a diagram of Kol'tsova's eyelid conditioning apparatus), while the presentation of each of the remaining 10 objects was unaccompanied by any extra stimulation. In the second group, in which a different set of 25 objects was used, the showing of all objects was accompanied by the air puff, but only 15 of them by the experimenter's saying *"veshch'."* Posttraining tests were made of both blink conditioning and of generalization-differentiation when all the objects were placed before the children and the experimenter said *"Vozmi veshch'"* [Pick an object. Take something.]. In both tests, the performance of the first group was clearly superior, the second group failing to develop even simple conditioning. The experiment is obviously a significant illustration of the interaction of the first and second signal systems: reciprocal facilitation when the two systems are correlated (first group) and reciprocal interference when there is a discrepancy between them (second group).

4. The presentation of five different and differently colored geometrical figures—red sphere, green pyramid, white cube, blue ring, yellow rectangle—to six 24-month-old children was accompanied by the experimenter's saying *"veshch'"* and delivering an air puff to the children's eyes. The presentation of four other objects—electric switch-key, drumstick, paper chain, iron disc—was accompanied by the experimenter's saying *"pustyak"* [nothing, trifle, trash] and omitting the administration of the air puff. The performance of the children of this group with respect to both conditioning and generalization-differentiation was even superior to that of the children of the first group in the preceding experiment, when the verbal differentiation of the puff unaccompanied objects consisted not of a special differential word but of the omission of the positive word. Yet, when 10 additional geometrical figures were accompanied by the air puff and the saying of *"veshch',"* both the conditioning and the generalization-differentiation were impaired and were restored only when the pre-

sentation of some objects was coupled with the experimenter's saying *"pustyak"* and delivering no air puff. This experiment obviously corroborates more specifically the one preceding, pointing up, in addition, the particular value of balanced differential conditioning and clear verbal differentiation in the development of integrated conditioned-verbal reactions (in Russian terms, the value of a balance between excitation and inhibition in a balanced interaction between the first and second signal systems).

5. Five geometrical figures and four other objects—identical to those of the preceding experiment—were presented to six 24-month-old children. The presentation of the figures was accompanied by the experimenter's saying *"veshch'"* and delivering an air puff to the children's eyes, and of the other objects by saying *"pustyak"* and giving the children candy. With this procedure, in which different reactions were attached to each of the two groups of stimuli, the children did even better both in the conditioning and in the generalization-differentiation of their reactions to the experimenter's saying *"Vozmi veshch'."* And it took 20 additional geometrical figures, rather than 10 as in the preceding experiment, to impair the children's performance.

6. A toy fishing game consisting of a cardboard aquarium, a fishing pole with a magnet, a cardboard pail, and several metal fish was presented a number of times to 14 17-month-old children, divided into two equal groups. The first group was given the opportunity to handle and play with the objects of the game while the second group was only shown them. Neither group had ever seen the objects before and in both groups the experiment comprised two parts, each lasting 10 days. In the first part, the experimenter accompanied the showing or handling of all the objects with saying *"igrushki"* [toys]; in the second part, begun after 13 of the 14 children had mastered the first part (that is, imitated the word and pointed to the game when it was pronounced preceded by "Where is"), each object was shown or handled separately to the accompaniment of the words *"stenki"* [little walls], *"udochka"* [little fishing pole], *"rybka"* [little fish], and *"vedro"* [pail]. The data are quite clear in disclosing differences between the two groups. Four children of the first, the handling-the-objects, group mastered the first part of the experiment in 2 days and the remaining three in 3 days. On the other hand, the task took four children of the second, the shown-the-objects, group 6 days, and two, 9 days; and one did not learn it at all in the 10 days of experimentation. Moreover, the second part of the experiment, requiring imitation of each of the four words and pointing to each of the four objects when the appropriate word was pronounced with the addition of "Where is," was mastered, in the course of 10 days, by all the children of the first group but by none of the second. The implications of this simple experiment hardly need explanation: the role of motor reactions and kinesthesis in the emergence of language. The reviewer wishes, however, that the experimenter had reported more specifically about the equating of the visual and the motor-kinesthetic stimulations.

Phylogenetic and ontogenetic CR comparisons. The number of Russian studies in this area is exceptionally large and the area is indeed the major division of the field cutting across all other categories. The first question that comes to mind is obviously the relation of CR efficacy to evolution, on the one hand, and to maturation, on the other. Twenty-five years ago, review-

TABLE 3

SPEED OF SIMPLE DISCRIMINATED OPERANT CONDITIONING IN FISH, CHICKENS, DUCKS, PIGEONS, RABBITS, DOGS, AND MONKEYS

Animal	*N*	Conditioned reaction	Conditioned stimulus	Conditioning trial			
				First appearance		CR stabilization	
				Range	Median & *SE*	Range	Median & *SE*
Fish	35	Pulling a bead	Green light, bubbling of water, blue light, white light, bell, flickering light	2–35	8±1.52	4–89	21±1.19
Chickens	11	Pecking at a pedal	Bell, green light, beat of metronome, white light bubbling of water	3–20	9±1.79	17–50	32±4.44
Ducks	4	Pecking at a pedal	Beat of metronome	8–19	17.5±2.82	24–102	88±19.96
Pigeons	4	Pecking at a pedal	White light	4–8	4.5±1.03	12–28	24±3.98
Rabbits	36	Pulling a ring with the teeth	White light, tone, bell	2–29	6±1.10	13–120	36±5.24
Dogs	21	Pressing a pedal, pulling out a drawer of a feeding-box, pulling a ring with the teeth	Bubbling of water, bell, metronome-120, whistle, tone, tapping sound	3–87	7±6.04	5–190	45+12.29
Monkeys	14	Pressing a lever, pulling out a drawer of a feeding-box	Bubbling of water, buzzer, metronome, bell, metronome-120, red light	3–35	9±3.20	7–120	32.5±9.66

ing one aspect of this CR efficacy, that of speed of simple conditioning, the present writer was rather specific in stating that "the speed of simple conditioning increases in phylogeny and in the first few years of [human] ontogeny" (Razran, 1935, p. 117), although even then he was puzzled by data showing that conditioning is faster in fish than in amphibians, and he surely was in doubt about the exact role of language in the first years of human conditioning. At present, with available evidence manifoldly multiplied, the 1935 statement surely needs qualification, indeed revision and a good deal of retraction. For one thing, there is the radically masking factor of ecology, the species-specificness of stimuli and reactions such as: (*a*) the vast differences between rabbits' reactions to the sounds of rustling leaves and to a buzzer as already discussed earlier with respect to the OR (Figure 36); and (*b*) the simple fact, pointed out by Voronin (1957), that it is so much

more difficult to train a dog to lift his hind paw than his fore paw. For another thing, cumulative evidence of 20 experiments in Voronin's laboratory, summarized and treated statistically in Table 3, clearly shows no differences in speed of simple discriminated operant conditioning among fish, chickens, ducks, pigeons, rabbits, dogs, and monkeys (Voronin, 1954, 1957).

On the other hand, reports of experiments from Voronin's laboratory show also that extinction of the above type of conditioning was considerably slower in the fish than in the other vertebrates tested: 28–78 nonreinforcements versus 6–15 for turtles, 11–84 for chickens, 10–30 for rabbits, 7–15 for baboons, and 8–10 for chimpanzees (Voronin, 1957). (Note the apparent absence of definite evolutionary differences among the other animals.) And there is no lack of evidence to reveal that, aside from differences in mere sensory capacity, evolutionary factors operate in the development of complex conditioning: delayed CRs, complex differentiations, transformation of CSs from positive to negative URs and vice versa, and, above all, pattern or configural conditioning.

A few reports on configural conditioning will be detailed here. Yordanis (1959) compared several classes and orders of vertebrates with respect to inhibition-disinhibition differentiation: that is, imparting to a stimulus a double CR value so that it decreases conditioning when compounded with one CS and increases it when combined with another—a mechanism supposedly basic to effective configural conditioning. He found the task impossible for turtles; difficult for pigeons; somewhat easier for rabbits; and progressively easier for dogs, monkeys, and chimpanzees. Baru (1954) noted that rabbits could be conditioned to differentiate between the various sequences of a successive three-link compound CS—bell, light, buzzer—and between the compound and its components. But in the same laboratory Prazdnikova (1955) encountered difficulties in training fish to develop even one successive compound differentiation, between a three-link CS—bell, light, bubbling of water —and its reverse sequence; while in Beritov's laboratory, dogs, but not rabbits, could be conditioned positively to each of the components of a four-link successive CS—340 + 680 cps tones + two bells of different timbre and intensity—and negatively to the total compound (Beritov & Bregadze, 1929).

Moreover, even with respect to the speed of simple conditioning, an evolutionary factor seems to be quite operative in invertebrates, at least in their first 14 phyla. Finally, it should be added that the problem of the evolutionary reversal of conditionability in amphibians seems to have been solved by the extensive cerebellar and cerebral ablation experiments of Karamyan (1956). Karamyan's data are quite unmistakable in revealing that, while in fish the ablation of the cerebellum abolishes both formed CRs and conditionability and ablation of the cerebrum affects neither, the poor conditionability of amphibians is little affected by either operation; or, in other words, the amphibians are a transitional group of animals in whom the cerebellum has lost power and the cerebrum has not yet acquired it (neuromorphological evidence corroborates this account).

Space prevents special discussion of ontogenetic CR aspects, and perhaps not much needs to be said. In general, ontogeny here repeats phylogeny, but account must obviously be taken of maturation stage at birth. Volokhov (Volokhov et al., 1959) reports studies in his laboratory that the first CR (defensive) in baby guinea pigs appeared on the first day; in pigeons after 6–7

days; in rabbits after 7–11 days; in rats, 10–15 days; in dogs, 17–25 days; and in cats after 22–28 days. And Kasatkin (1957), reviewing a large number of Russian studies on conditioning of human infants, concludes that true CRs appear no earlier than 8–9 days after birth. The specific crux of human ontogeny is of course the emergence of language or verbal conditioning, discussed earlier, and the further consideration that language symbolization or phonetic and semantic conditioning, CR compounding-*Gestaltung*, proprioceptive conditioning, interoceptive conditioning, and the orienting reflex are hierarchically related—a topic that will receive its due in the next section on systematic theory.

Systematic Theory

The systematic theory suggested by the empirics of the three core and four related areas of Soviet psychophysiology—the former reviewed in comparative detail, the latter merely epitomized—pertains, as might be expected, to basic learning or conditioning. And in the writer's opinion, what is suggested may best be formulated as a three-level theory: a first level of simple primary exteroceptive and sensory-interoceptive conditioning that is little modified by proprioceptive and motor-interoceptive CS feedback—the classical variety; a second level of exteroceptive and sensory-interoceptive conditioning that is greatly modified by CS feedback and gives rise to operant conditioning, on the one hand, and to configural conditioning, on the other; and a third level of verbal conditioning which, beginning as simple classical-sensory and operant-motor conditioning, quickly evolves into a special kind of configural conditioning in which sets of surrogate compound CRs emerge, and supraordinate semantic and subordinate phonetic (or phonetographic) units develop. The theory might also be described in terms of three (not two) signal systems: a first signal system of primary environment generated exteroceptive and sensory-interoceptive signals; a second signal system of secondary, response produced proprioceptive and motor-interoceptive signals; and third, a signal of signals surrogate system of words and their equivalents. It will be noted that the levels or signal systems are assumed to exist and operate in hierarchical fashion: first, second-plus-first, third-plus-second-plus-first. The higher levels or signal systems subsume but do not supersede the lower ones, indeed are dependent on the co-presence of the lower ones. And it might be added that, despite century-cumulated evidence and intimate relevance to human control, the third level or signal system is in a lower state of systematization than are the first and the second, particularly the first.

The classical-operant differential. For some time the writer (Razran, 1939a) has maintained that in our present state of knowledge all that can be safely said is that there are two types of conditioning, one in which the modified reaction, *d*, assumes some characteristics of the modifying reaction, *G*, becoming *dG*, and one in which the modified reaction becomes strengthened by the modifying one, becoming *dD*. The writer does not of course object to calling *dG* conditioning classical and, in deference to usage, *dD* conditioning operant or even instrumental (reinforcement conditioning would be better); and he finds, moreover, some general value in the terms respondent, operant, and instrumental as designations of particular classes of reactions. What the writer does consider unwarranted is the conventional assertion that *d*, the modified reaction, is necessarily operant or instrumental in *dD*, or operant, conditioning, and

necessarily respondent or noninstrumental in *dG*, or classical, conditioning. Paw-lifting may be *dD*, or operantly, modified even if it is respondently evoked; and *dG*, or classically, modified even if it is operantly emitted (Konorski & Miller, and others). Likewise, the frequency of a dog's scraping a rug while it is being fed or an infant's fingering a button on his mother's robe while being nursed may well be *dD*, or operantly, increased or conditioned, even though the reactions are admittedly noninstrumental; and there is plenty of evidence for *dG*, or classical, CR modifications of instrumental reactions.

In other words, in the writer's view, the main problem of the Pavlov-Thorndike, more modernly, Pavlov-Skinner dichotomy remains unsolved: when does learning or association produce a *dG* and when a *dD* reaction? Or we might say that the dichotomy has thus far been discriminated only semeiologically, in terms of manifestations and functional relationships (Hilgard & Marquis, 1940; Mowrer, 1947; Razran, 1939a, 1955a; Schlosberg, 1937; Skinner, 1935, 1938, 1957, 1959; Solomon & Wynne, 1953) but not etiologically. And it is in the realm of etiology that an analysis of the empirics of current Soviet psychophysiology, with, to be sure, American psychology as a backdrop, is of particular heuristic value.

Four different categories of Soviet CR experiments bear upon the classical-operant problem:

1. Studies of operant conditioning such as paw-lifting and runway reactions in which Russian and Polish, unlike American, experimenters typically take account also of concomitant classical components such as salivation and eating-accompanying motor reactions and in which, moreover, the Russian experimental design is almost always a double and not just a single link: that is, the modified reaction is studied not only as a function of subsequent reinforcement but also as conditionable to antecedent stimulation (the discriminated operant, in Skinner's terms, which, incidentally, the writer finds is neither in essence nor in functional manifestations in any way distinguishable from what Pavlov had studied)

2. Current classical CR experiments in which concomitant CS produced orienting reflexes are carefully measured so that the reaction change to the CS is investigated not only in terms of the acquired CR but also as a change in the CS's own premodified reaction

3. Experiments in which the original reaction to the CS is incompatible with that to the US, as when, for instance, in food conditioning, the CS is an electric shock or some other aversive stimulus

4. Cases in which the effects of the acquired CR on the UR are studied, incremental effects being seemingly related to classical *dG* modifications and decremental effects to the operant *dD* variety. For convenience, control, and theoretical uniformity, only experiments with food as the US (or reinforcement) are being considered in any of the four categories.

The results and implications of the experiments in the first two categories are the very basis of the suggested *dG* classical-*dD* operant differential in the introductory paragraph of this section. For they clearly indicate that while (*a*) CR modifications are eventually of either the *dG* or the *dD* type, (*b*) some reactions are capable only of *dG*-modification, and (*c*) some quickly acquire *dD* characteristics, it is also true that (*d*) *dD* modifications contain *dG* ones as subsistents, (*e*) *dG* modifications become transformed into the *dD* variety when CSs are increased in intensity and thus evoke marked ORs and con-

sequent proprioceptive CS feedback, and (*f*) *dG* modifications manifest themselves in general (except for a special case to be discussed in the next paragraph) only when the ORs of the to-be-modified reactions are either small or readily extinguishable and thus devoid of feedback. Or, more formally and succinctly: *Operant* dD *modification comes into being only when to-be-modified reactions involve a large amount of motor or proprioceptive CS feedback*—which in rough traditional terms may further be simplified as: *Classical conditioning is primarily a modification of sensory reactions and operant conditioning a modification of motor reactions,* with the obvious addition that at a certain level of reactivity the sensory-motor dichotomy is a matter of quantity rather than of quality of stimulation and the needed qualification of the already mentioned special case.

The special case under discussion refers to experiments in the third category in which classical *dG* modification occurs despite undoubted extensive CS feedback involvement. However, a moment's thought reveals that the case is a very special exception hardly refuting the general principle: a modification resulting from the confrontation of two basic and, except for stimulation differences, biologically equally potent antagonistic URs resembling reflex interaction at a spinal level, and thus is quite different from typical CR learning, in which only one reaction, the modifying one, is basic and potent, the other, the modified one, being ancillary, weak in potency, and readily and unantagonistically integrable with the modifying reaction (the question of second-order conditioning and verbal association is a separate matter and need not detain us here). Indeed, it may well be argued that the experiments of the third category illustrate a most primitive, pre-true-conditioning, form of modifiability, characteristic particularly of simple organisms and simple systems whose reaction repertories are both limited and not yet adequately organized into a dominant-subordinate reaction hierarchy. And, again, it may surely be said that in view of its greater universality (occurrence in lowest phyla of the animal kingdom, in few-days-old animals and infants, in interoceptive systems, and lesser dependence on type of CS and UR), lesser disruptability (ablations, drugs), and some other considerations, classical conditioning is a phyletically older form of learning than is operant conditioning.

Finally, the studies in the fourth category point to a rather general yet adaptively very significant classical-operant differential which, as far as the writer is aware, has not previously been noted in either American or Russian CR literature. What may be said to be the quantum of UR reactivity extends in classical conditioning to both the ways of bringing it about and its own magnitude or intensity, whereas in operant conditioning the UR's or reinforcement's own reactivity may actually diminish in the wake of its conditioning. An organism's food or sex reactivity—or sensitivity—will thus increase as a result of the many signals or classical CSs that become attached to it, but may decrease as a result of multiplication and variegation of operant CRs, the *means* of obtaining the food or sex. Some energy seems to be transferred from ends to means. Or, more specifically, in operant conditioning the energy transfer is the reverse from that of what it is in classical conditioning: from ends to means rather than from signals to ends. On the other hand, it must be kept in mind that signals and means are not ultimate terms of CR analysis and, as was already indicated, means involve also some signal CR modifications. Or, in

other words, all we may conclude systematically from the fourth category of experiments is that *dG* modifications tend to increase URs and *dD* modifications to decrease them, with the likelihood that in normal life situations the two types of effects neutralize each other and the URs are not radically changed.

Feedback and configural conditioning. The statement in the introductory paragraph of this section that CS feedback "gives rise to operant conditioning, on the one hand, and to configural conditioning, on the other" purports to convey three considerations: (*a*) the obvious fact that by their very nature operant and configural conditionings are altogether different evolvements of simple classical conditioning; (*b*) the postulation that although CS produced proprioceptive feedback is at the base of both types of conditioning, its specific mechanism of action is quite different in each case; and (*c*) the almost obvious deduction that configural conditioning is an evolutionary higher level of learning than is operant conditioning. Only Considerations *b* and *c* will be discussed. It should, for instance, be made clear that the postulation involves the premise that in operant conditioning the feedback is of a strengthening-a-particular-reaction kind whereas in configural conditioning it is of an integrating-a-number-of-reactions type—or, specifically, that in operant conditioning the feedback merely raises the status of a to-be-modified reaction to the extent that subsequent or concomitant URs strengthen its reaction rather than replace it by their own, whereas in configural conditioning feedbacks of a number of to-be-modified reactions combine and integrate to generate a CR that is separately UR modified and by all logic separately represented in the cortex of the organism. Again, with respect to Consideration *c*, it will be remembered that efficacy of configural conditioning correlates positively with ascending classes, orders, and families of mammalian evolution but that efficacy of simple discriminated operant conditioning varies little from fish to chimpanzee. And there is of course no doubt that configural conditioning expands immensely the realm of an organism's CR action, permitting it a vast variety of whole-part and permuted-whole differentiations and integrations of the stimulations of its surrounding environment and thereby also, it should be added, a lesser dependence upon the original nature of the stimulation and a closer tie-in with the organism's own "past." A view that configural conditioning is an organism's apogee of preverbal achievement would be hard to refute.[5]

The argument for proprioceptive feedback as a mediator of configural conditioning rests, however, not only on logic and postulations. There is also a body of empirical evidence. For some time now Russian experiments have disclosed a very substantial direct relationship between efficacy of configural conditioning and extent of CS accompanying, orienting reflexes, which obviously means extent of CS produced proprioception. And, then, there is the corroborative evidence of such studies as those of Kol'tsova, cited earlier, on the importance of kinesthesis in the development of infants' abstractions.

[5] Receptor compounding of stimuli must be distinguished from effector chaining of responses. In the latter case, the proprioceptive CR mechanism is by all tokens primarily a matter of summative integration rather than of suprasummative configuration—a mechanism which seems to the writer to involve too little extra systematic significance to be specifically treated here. It should be noted, however, that the Russians sometimes use the term "chained" instead of "compound" even with respect to stimuli.

The logical argument of "feedback and universals" has been popularized by students of cybernetics but is in need of more concrete amplification in the light of present-day knowledge of conditioning. In the writer's view, three related proprioceptive mechanisms are involved in CR configuring: compression, formalization, and *sui generis* cortical representation. Compression stems from the consideration that secondary proprioceptive stimulation is surely not so specific as the primary exteroceptive and sensory-interoceptive stimulation from which it is derived; or, in Russian terms, that CS accompanying ORs are by no means as specific as the CSs' reflections in respective analyzers. Formalization means that proprioceptive stimulation compares, so to speak, primary sensory stimulations which it receives in relation to itself and hence imparts to these stimulations a special set of formal—we might say extra- or suprasensory—properties such as: sequence, number, intensity and duration ratios, rhythm, proximity, similarity, continuity, and the like (one even thinks of *Einstellungen*). *Sui generis* cortical representation hardly needs enlargement, stating as it merely does that proprioceptive stimulations must have their own cortical representation, what the Russians call the motor analyzer. In fine, all that has been said here is that CS produced proprioception (also motor-interoception) provides the organism with a second recoded and separately stored dimension of acquired conditioned information, and that both logical considerations and empirical evidence point to this dimension as the mediating mechanism of configural conditioning.

Pavlov (1936) considered proprioceptive conditioning the basis of voluntary action, while cognition in general is in current Soviet theory related to either conditioning in general (Bykov & Pshonik, 1949) or to "neutral" orienting reactions (Leont'yev, 1959). In the tradition of earlier American motor theories of consciousness, the writer's thoughts have, however, run in the direction of regarding proprioception and proprioceptive conditioning as the phyletic and neural loci and foci of cognition's emergence as such. (Cognitive control is another matter that may perhaps need linguistic tools to be effective—Razran, 1935, pp. 120–124.) The thoughts are of course in the nature of a speculation, not at present testable in the sense that the relation of proprioception to configural behavior may be tested, and are thus really not integral to the present systematization. Still, it might be mentioned that the speculation is seemingly in line with the role of perception as an outgoing, organism generated activity; with the epistemological views of such philosophers as Perry and R. W. Sellars; is one which the writer has always found privately comfortable; and, incidentally, is also one that is accommodable to Lenin's gnosiology of praxis approximation of truth and activistic consciousness.

The specifics of verbal conditioning. Specific systematization of the experimental evidence of verbal conditioning is a difficult task. For even at the young age when language first begins to appear, full control of pre-experimental and extra-experimental variables is hardly possible, almost total separation of the baby-subject from his human-verbal environment being obviously the prerequisite. And in adult subjects there is the additional uncontrolled and barely controllable factor of the long ingrained fixity of verbal behavior which only very special techniques can pierce to gather glimpses of its developmental dynamics and essence. Plainly, CR experimentalists

may well have missed, by a few hundred thousand years, the opportunity of a thorough investigation of language at its base. Still, the fact remains that the CR method is the most basic, most genetic, and most objective in the field, and the aforementioned semantic CR experiments plus studies such as those of Kol'tsova, taken together with related natural and clinical observations, offer some systematic clues.

To begin with, there is no denying that a portion of verbal conditioning is not particularly specific and presents no particular problems. The basic mechanism in conditioning an infant to react appropriately to "Show me your nose" may well be little different from that of conditioning a dog to lift his paw upon command. Likewise, changes in elements of an infant's vocalizations, weakening and elimination of some and strengthening and fixing of others, may well proceed according to typical operant reinforcements and extinctions. Indeed, there is every reason to believe that words and their combinations not infrequently behave as no more than simple CR signals and simple operants even in adult life. Still, these simple mechanisms are doubtless only the birth and fringe characteristics of language dynamics, not its determining core. As stated earlier, even in modifications of purely somatic and visceral reactions of animals, simple CR mechanisms give way, through the development of proprioception, to complex configural ones, and only the efficacy of the latter correlates positively with evolution from fish to chimpanzee. And certainly one could not argue that evolution stops with the advent of man and verbal conditioning or language, eschew the glaring fact that language's main role is exactly that of configuring, or ignore the adduced evidence that proprioception is radically involved in the very rise of true language in early human ontogeny. If proprioception alone yields a second dimension of coding and processing conditioned information and of *sui generis* cortical representation of received stimulation, then language must by all tokens generate or create a third.

The specific higher level evolutionary characteristic of verbal conditioning in true language (that is, apart from and above its function as a simple CR signal or simple operant) is, however, not just that of compounding and configuring but that which might be called surrogation or perhaps better configural surrogation. Words and sentences are not merely configural CRs to different sequences of the same elements of stimulation and compound CRs to compressed classes of stimulations, but are also admittedly duplicates or surrogates of somatic—occasionally also visceral—reactions priorly possessed by the individual. That is to say, full-fledged verbal conditioning, unlike preverbal proprioceptive conditioning, gives rise not just to doubly coded information and to the integration of reactions to different stimulations, but also to double sets of effector reactions to the same stimulation, with consequent conflict, cooperation, and control of one set by the other (not to mention the consideration that verbal reactions generate their own extra proprioception). Moreover, because of inadequate CR capacity, inadequate conditioning, or extinctive effects, the reactive aspects of an individual's words and sentences fall behind their full stimulational values, creating the problem of semantic versus phonetographic (more correctly, phonemographemic) conditioning, that is, of fully compressed and configured verbal CRs versus those in which one or more CR steps have not been developed or had been lost. And again, there is experimental reason to believe that

configured verbal CRs become further organized, perhaps through the mediation of their own proprioception, into hierarchies and propositional arrangements (see earlier section on Semantic Conditioning). A whole new realm of what might be called sememes, fully configured semantic CR units anchored to a variety of words or phonemes, thus comes into being and interacts with words or phonemes that have been little or even not at all attached to semantic equivalents. Or, in other words, behavioral psychology must face not only the problem of the verbalization of S-R units but also that of their "semanticization."

In short, verbal conditioning appears by all tokens to recapitulate all forms of CR modifiability—it is not just a higher but the highest level of learning, and not just a third level but a third-plus-second-plus-first level, and, moreover, a third-plus-second-plus-first level interacting continually with a mere second-plus-first and a mere first level. An important phase of the interaction of verbal with nonverbal conditioning is involved in the mechanism of the genesis of verbal control of somatic and visceral reactions. The problem has been recently studied by several Soviet psychologists, notably by Luria, experimenting with the genesis and course of simple voluntary reactions in young children (Luria, 1956). But both space and the complexity of the problem forbid discussion here. However, the writer would like to be permitted to quote a statement he had made 26 years ago (Razran, 1935). He then spoke of "symbolic reactions as a term for verbal-conscious-volitional processes" and said that the individual's

> choosing and rejecting system [is] . . . the sum total of his symbolic "past" that has gradually become dominant over his somatic and visceral "present." Its action and organization are held to proceed ultimately according to the same principles of interdependence, conditioning, and dominance as the somatic and visceral unsymbolic—or little symbolic—system (p. 120).

In the main, the writer's view has changed little since, except perhaps that he would now be less tentative about the conditioning of verbal reactions and would point with pride to our increased evidence of somatic and visceral conditioning.

General Summary—Appraisal

Ten short statements are offered here as a general summary-appraisal of current Soviet psychophysiology. They are offered in lieu of a conventional summary, which would be difficult and which in a compressed theoretic sense was attempted in the preceding section. And they are intended to answer such questions as: What are the general distinctive characteristics of current Soviet psychophysiology? In what ways and why does it differ from corresponding American behavioral psychology? Which of the differences are a function of the Soviets' special socioeconomic and philosophical system and which are merely a result of historical differences in the development of the two disciplines in the respective countries? In which areas are the two disciplines likely to get closer to each other (or should get closer to each other) and in which will (or must) they remain apart? What do Soviet psychophysiologists do that we do not do and should do? And what should we not do or can we not do? More specifically, the first 2 of the 10 statements pertain to the general theory of Soviet psychophysiology and the remaining 8 to its general research program. All statements begin with characterizing epitomized phrases.

A single broad, otherwise nondoctrinaire, associationistic system or ap-

proach. This of course follows Pavlov. But, as noted earlier, most present-day research is in areas which Pavlov only preindicated or which were unknown in his day (interoceptive and verbal conditioning and the orienting reflex are examples of the first category, and EEG correlates of conditioning and the isolation of semantic conditioning illustrate the second). And, while in the early '50s adherence to Pavlov's specific views was strict, it has by now radically loosened, although, to be sure, the associationistic system itself is always upheld.[6] There is no doubt that universal acceptance of a single broad system leads to an economy of effort vis-à-vis, for instance, American practice in which associationistic experimentalists and theoreticians spend so much time in defending and proving their associationism. And it is of course also true that the acceptance of a broad system discourages the development of narrower ones, unlike the vogue in this country where theoreticians are not infrequently tempted to expand a study of a particular aspect of association into an all-embracing general system. Yet, it is quite obvious that our social philosophy cannot permit—and we are glad that it cannot—restriction of any school of psychology.

Little conceptualization. Pavlovian physiology combined with a fixed Marxist-Leninist body-mind view, plus the consideration that Soviet psychophysiologists are by training physiologists and not psychologists, is not conducive to the type of psychological conceptualization that is so characteristic of American behavioral psychology in the last few decades. Hence, it is quite evident that while a large portion of American behavioral psychology has often been mainly concerned with the problem of what *is* associated or conditioned, its Soviet homolog has been busy finding out what *can* be associated or conditioned and, as we have seen, has expanded manifoldly the realm of conditionables—no doubt a very notable contribution. Yet, it is also quite true that Soviet psychophysiological theorization is very unsophisticated—a fact noted by its own critics (Editorial, 1959, p. 163)—and the field is literally clogged with unintegrated empirical findings, just as American behavioristics may well be classed as overloaded with theorizations. A fair statement would seem to be one characterizing American behavioristics as highly overconceptualized and Soviet psychophysiology as markedly underconceptualized.

Little demand from social and clinical psychology. Social psychology in the American sense does not exist in the Soviet Union, while mental illness

[6] The following is a quotation from an editorial in the 1959 March–April issue of the *Zhurnal Vysshey Nervnoy Deyatel'nosti im. Pavlova* [The Pavlov Journal of Higher Nervous Activity]: ". . . much attention is given to interpretations of one or another quotation from Pavlov, whether he was an advocate or an opponent of psychology as an independent science, whether he intended physiology to engulf psychology, and the like. Although we are interested in such topics, it is now more important to us to determine how we ourselves regard the problems in the light of present-day science which, naturally, does not and cannot stand still" (p. 162). And again it might be mentioned that earlier practices of Soviet psychophysiologists and particularly psychologists of stocking their theoretical and even experimental articles with lengthy and numerous quotations from Marx, Engels, Lenin, and Stalin (typically in introductions and conclusions) have by now practically disappeared. In only one of the 17 contributions to the 1959 *The Science of Psychology in the USSR* (Anan'yev et al.) may such quotations be found, and there are none whatsoever in Sokolov's 1958 *Perception and the Conditioned Reflex* and in the 1958 and 1959 volumes on the orienting reflex. To be sure, Pavlov continues to be cited voluminously—but then there is no reason why he should not be.

is by all tokens a problem of much less concern than it is in the United States. There is thus little dilution of research programs and idea systems by the pragmatics of immediate applications and, we might add, by the economics of private psychotherapy, a nonexistent profession. Moreover, while Soviet psychophysiology, like American psychology, is applied widely, as might be expected, to problems of education, for reasons that need not detain us here, professional Soviet educators seem to be able to utilize psychological principles without much dilution, change, and popularization.

Much concern with evolution. Darwin is the Soviets' most respected and accepted non-Soviet scientist, his views being in the main regarded as prolegomena to Marxism-Leninism (schools offer special courses in Darwinism). The evolution of higher nervous activity, that is, phyletic and ontogenetic differences in conditioning, has thus always been a dominant portion of Soviet research and thought. But, evolution is of course an integral constituent of contemporary science anywhere and at one time has indeed loomed large even in specific systematic psychology. Its comparative present-day experimental and theoretical neglect in American comparative and genetic psychology has always seemed to the writer to be one of our most glaring shortcomings.

Little interest in maze, problem box, and other "trial-and-error" types of animal learning. The Soviet-American differential is here no doubt a matter of historical differences in the development of the scientific analysis of learning in the two countries and is unrelated to special characteristics of the Soviet system. It needs, however, to be pointed out that with the advent of Skinner, interest in conventional trial-and-error learning is continually fading even in this country and that, on the other hand, complex operant animal training and its scientific analysis are becoming, as was noted earlier, an integral part of CR programs in Soviet laboratories.

Many studies in compound and configural classical conditioning. The studies are evidently a counterpart of American involvement in maze-and-problem-box and other complex learning, offering the advantage of fully controllable follow-ups of the dynamics of the conversion of the simple into the complex. The negligible number of such experiments in this country is obviously not unrelated to our accelerated neglect of classical conditioning in general—another deplorable characteristic of recent American learning psychology.

Much concern with visceral action. In its CR form this concern has for years been almost a Russo-Soviet monopoly. In its UR manifestation it has become so in recent years with respect to interoceptive stimulations, the numerous studies of which demonstate that no S-R analysis is complete or correct when no account is taken of the almost ever-present interoceptive parameters. A Soviet-American professional differentiation should be noted here: namely, the fact that this type of CR research requires special skills which the American students of conditioning do not usually possess while Americans who possess the skills (gastrologists, urologists) are not as a rule interested in conditioning.

Verbal and semantic conditioning. Soviet intensive interest in the area is, as was mentioned earlier, of recent vintage. Its significance needs no emphasis and it is of course an area which is right in line with American psychologists' research and thought.

The orienting reflex. The topic has been presented in considerable detail in

the text and needs no further elaboration, except to point it up as a striking example of directed research—the fact that, while the topic is old, 115 of 164 available experiments pertaining to it have been reported in the last 6 years.

The neurology and pharmacology of conditioning. As noted, the reviewer has as yet not fully digested the experimental material in the area. A preliminary perusal discloses, however, that the area—EEG correlates of conditioning, neuromorphological bases, the effect of drugs and of ablations, and the like—is beginning to receive top priority in the Soviet CR research program, and that apparatus and surgery are by all tokens technically adequate. The area is of course one in which non-Russian research is both extensive and readily synthesizable with what the Russians are doing. And there can of course be no question about the area's most basic systematic and pragmatic significance.

Final Word

Only the first 3 of the 10 statements in the summary-appraisal of current Soviet psychophysiology relate to research programs and approaches which are specific to the Soviet system and philosophy and are not transferrable to our views and practices. The remaining 7 statements deal with areas in which there are no basic differences between what Americans and Russians want to do and think, and in 5 of these areas Russian research is clearly a systematic and pragmatic challenge—we are behind and must catch up.

To be sure, the writer has dwelt only on the strengths of current Soviet psychophysiology. There are surely also weaknesses. However, frankly, the writer is not interested in Soviet weaknesses—let the Russians worry about them. The review is directed to a non-Russian audience and does not involve the general problem of "who is ahead."

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